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October 15-16, 1979

McLean, Virginia

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16. ABSTRACT

The purpose of this report is to provide documentation of the Regional Economic Modeling Workshop held at the Mitre Corp. in McLean, Virginia on October 15-16, 1979. The workshop was sponsored by the Office of Research and Development, U.S. Environmental Protection Agency, with cooperation from the Office of Technology Impacts, U.S. Department of Energy. Both EPA and DOE have faced in recent years the increased need to address questions of geographic distribution of economic and energy-related activity and associated environmental pollution releases at an increasingly disaggregated level of detail. The Strategic Environmental Assessment System (SEAS) has been one modeling tool through which both EPA and DOE have attempted to meet such needs.

The Regional Economic Modeling Workshop was conceived to bring together experts in regional and economic modeling, users of SEAS, SEAS developers and operators, and other interested parties to discuss possible methods for improving the regional projection capabilities and to solicit the group's recommendations. This volume documents the results of the workshop and is intended to serve as a reference source in the design and implementation of an improved regional projection capability based on the workshop recommendations.

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I. INTRODUCTION

The purpose of this report is to provide documentation of the Regional Economic Modeling Workshop held at The MITRE Corporation in McLean, Virginia, on October 15 - 16, 1979. The workshop was sponsored by the Office of Research and Development, U.S. Environmental Protection Agency (EPA) with cooperation from the Office of Technology Impacts, U.S. Department of Energy (DOE).

Both EPA and DOE have been faced, in recent years, with increasing needs to address questions of geographic distribution of economic and energy related activity and associated environmental pollution releases, at an increasingly disaggregated level of detail. These needs are described in more detail in section II of these proceedings. The Strategic Environmental Assessment System (SEAS) has been one modeling tool through which both EPA and DOE have attempted to meet such needs. It has become clear, however, that a significant improvement in the SEAS capabilities or an alternative modeling tool is needed to provide credible information at the level of detail required for some applications.

The Regional Economic Modeling Workshop was conceived to bring together experts in regional and economic modeling, users of SEAS, SEAS developers and operators, and other interested parties to discuss possible methods for improving the regional projection capabilities and to solicit the group's recommendations. This volume documents the results of the workshop and is intended to serve as a reference source in the design and implementation of an improved regional projection capability based on the workshop recommendations.

Section II of this volume contains several issue papers prepared as background material in advance of the workshop. Section III is a partial transcription of the final summary session of the workshop containing the substantive recommendations of the working groups and final comments. Section IV is an attempt to organize the Workshop recommendations into a comprehensive summary. This section was written by Dr. Nazir Dossani, after the workshop, based on the transcript of the summary session. Several Appendices contain information concerning the mechanics of the workshop, names of participants and written recommendations received before and after the workshop.

A rather large set of materials was assembled and distributed to all participants explaining current procedures in SEAS for obtaining regional information. This material is not included in the proceedings but can be obtained by contacting the EPA Project Officer, Paul Schwengels, at (202) 426-9434. (See MITRE Document WP-79W00881.)

It is the unanimous opinion of all those from both EPA and DOE who participated in the workshop effort that the results have been very useful. The recommendations received are both the result of and the stimulus for a great deal of productive thought. These recommendations will be of great value as EPA and DOE attempt to improve existing analytical capabilities. The enthusiastic and constructive participation of all workshop attendees was instrumental in producing successful results and is greatly appreciated.

The following individuals provided substantial assistance in the preparation for and conduct of the Regional Economic Modeling Workshop:

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Robert Nakosteen
Juan Gonzales
Regional Studies Division
Tennessee Valley Authority

This assistance was crucial to the success of the workshop and is gratefully acknowledged.

Paul Schwengels

Paul Schwengels
EPA Project Officer

II. BACKGROUND PAPERS

This section contains the background papers that were included in the briefing document distributed to participants prior to the workshop. Some of these papers were also presented by the authors at the preliminary session of the workshop. (See Appendix B--Workshop agenda.) The papers and their authors are:

Rationale for a Regional Economic Modeling Workshop
    by Paul Schwengels

An Evaluation of Current Regionalization Procedures in the Strategic Environmental Assessment System
    by Nazir G. Dossani

Improving the Region Module of SEAS: Suggested Approaches and Potential Problems
    by Peter D. Hall and Kevin M. Hollenbeck

Approaches for Improving the SEAS Region Model: A Discussion Paper
    by T. R. Lakshmanan

Comments for the SEAS Regionalization Workshop
    by Robert A. Nakosteen

Memos: Regionalization Aspects of the Industrial Boiler Model.
Additional Aspects of Industrial Energy Use and Regionalization
    by Barry Sedlik

Improving the SEAS Regional Capability
    by David Paul Vogt

Rationale For A Regional Economic Modeling Workshop

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INTRODUCTION

Both the Environmental Protection Agency (EPA) and the Department of Energy (DOE) are faced with frequent needs to evaluate and anticipate the effect of government policy on the economy and the environment. Both agencies have developed a number of computer simulation models to assist in meeting these needs. The Strategic Environmental Assessment System (SEAS) is one such model currently used by both EPA and DOE. SEAS is a system of linked computer models which can be used to project the magnitude, sources, and distribution of pollution releases to the environment resulting from input assumptions with respect to environmental regulations, levels of energy supply and economic activity. The interrelationships between regulation, energy, economic activity and environmental impact can be analyzed by varying input assumptions and observing changes in outputs.

SEAS clearly attempts to deal comprehensively with these questions at a level of detail much greater than is normal for national models. The system is currently being operated by both DOE and EPA in a variety of policy applications which require this comprehensiveness and level of detail. There is, however, widespread agreement among developers, users and critics of SEAS that significant imperfections remain in the system. Although SEAS has been upgraded and refined continually since its beginnings in 1972, the magnitude of this task is such that improvement and upgrading of the system will undoubtedly continue over a number of years. Several areas in both model structure and data bases have been identified in which further improvement could significantly increase the credibility and therefore policy relevance of the model results. Both DOE and EPA are engaged in ongoing reviews of SEAS. Model development and data needs and implementation plans are being generated as a result of these reviews.

One area which has been of increasing concern to both EPA and DOE is the capability to disaggregate national projections of economic activity by geographic region. There is considerable concern about deficiencies in the regionalization procedures currently used in SEAS. (Many of these deficiencies are discussed in some detail in companion papers.) At the same time, a number of policy analysis activities are underway or being considered in EPA and DOE which require a credible capability to project regional economic activity under various sets of conditions. The result is a great deal of interest in both agencies in improving this capability within SEAS or in developing some alternative capability which is compatible with SEAS. As one step toward achieving this objective, a workshop is being conducted to solicit recommendations for improvements from a selected group of individuals representing SEAS users, SEAS developers, outside experts in regional economics and modeling and other interested parties.

This paper will describe a number of current and planned activities for which an improved regional economic projection capability is desirable. These activities are carried out by two programs within EPA's Office of Research and Development--the Strategic Analysis Group (SAG) and the Integrated Technology Assessment (ITA) Program--and by the Office of the Assistant Secretary for Environment (ASEV) in DOE. This set of policy applications provides a context for discussion of current problems with the SEAS regional economic capability and recommendations for an improved capability. The applications for which such a capability is to be used should, of course, be an important determinant of the method used and the level of detail required. This paper will also touch on resource and time constraints which will limit the ability to implement improvements. This should provide some insight concerning the kinds of recommendations which would be most useful. Additional papers describe in more detail the current system for regionalization within SEAS and a number of suggestions for improvement. Collectively, these papers provide the background information necessary to conduct an informed discussion of these questions during the workshop to be held in October 1979.

STRATEGIC ANALYSIS GROUP

Within EPA's Office of Research and Development the Strategic Analysis Group (SAG) is concerned primarily with identification of possible future environmental trends or problems as a guide to long-range planning of environmental research. Near term objectives of the SAG include:

- improvement of present EPA capabilities to make credible projections of the quantities of pollutants likely to be introduced into the environment both nationally and regionally under different macro-economic and energy and environmental policy assumptions; and
- analysis of these projections to include a more detailed assessment of consequences that can be anticipated when the projected quantities of pollutants are introduced to the environment.

The first of these objectives is, of course, directly linked to the ability to project regional distribution of economic activity. The general approach within SEAS is to regionally disaggregate economic activity, then to apply environmental coefficients to yield regional projections of environmental residuals. Obviously, economic regionalization is a key component of this approach. The second SAG objective relates to improved analyses of the results of this projection effort. The fact that more sophisticated analysis is anticipated adds urgency to the desire to improve the quality of the projections themselves.

Many of the specific current and planned activities of the SAG include projections of possible trends in magnitudes and distribution of environmental pollutants. For example, with certain assumptions concerning national economic growth and level of environmental regulations, projections can be generated of the total quantities of criteria air pollutants--SOx, NOx and particulates--in a given region in future years. National and regional trends in the levels of these pollutants emitted can be projected under different scenarios.

The trend projections used by SAG to date have, by and large, been disaggregated only to the level of federal regions. There are, however, issue areas (e.g., distribution of air pollutant emissions), in which a much finer level of detail would be desirable, if credible.

The SEAS generated regional projections of environmental pollutants are being used as inputs to the annual Environmental Outlook Report--a Congressionally mandated report used in conjunction with a corresponding Research Outlook Report to provide information for the environmental research planning process in EPA. These projections are used despite concern over numerous deficiencies in SEAS, including those related to regionalization, because they frequently provide the only available information.

The regional projections are also used in the preparation of periodic briefings to EPA regional offices pointing out potential problems in the regions. These activities, of course, become more credible and useful to the extent that the economic regionalization procedures in SEAS become improved. Of particular interest are those industrial sectors which are pollution and/or energy intensive.

INTEGRATED TECHNOLOGY ASSESSMENT

The Integrated Technology Assessment (ITA) program within EPA's Office of Research and Development will require regional economic projections at a very detailed level for a number of policy applications. The program has conducted, or is conducting, several national and regional integrated assessments such as the Ohio River Basin Energy Study, the Technology Assessment of Western Energy Resource Development, the Integrated Technology Assessment of Electric Utility Energy Systems, etc. In all of these studies, SEAS has been used to generate some information concerning regionally distributed economic activity and environmental residuals. It is anticipated that, with an improved regionalization capability, SEAS can play a greater role in future integrated assessment and can provide a consistent framework of regionalized economic activity and environmental residuals which will tie together results of the analyses conducted in various national and regional assessments.

Several integrated assessment activities are being considered which would intensify the need for a credible and consistent regional economic projection capability. One possible study is an integrated assessment of a solar and conservation based society/economy. Opportunity for employment of solar and conservation technologies and the impact of their employment vary considerably depending on geographic location. The ability to project regional distribution of economic activity credibly is crucial to a number of the analysis tasks which would be included in such a study.

Another study under consideration is an integrated assessment of the impacts and issues associated with the rapid shift in geographic location of industrial activity and population which is currently occurring in this country. The shift is popularly referred to as the "Sunbelt" phenomenon. Obviously, the ability to project the regional distribution of economic activity on a very fine scale is critical to such a study. Either an improved SEAS capability or some alternative method is necessary to provide patterns of economic activity under various conditions, as an early step upon which much of the analyses must be built. These patterns most likely need to be disaggregated to BEA areas and must be produced using a credible and consistent methodology. For some analysis tasks (e.g., regional air quality modeling), a method will likely be required for distributing at least some types of economic activity at an even finer geographic level.

Both of these planned Integrated Assessment activities will place emphasis on sectors of economic activity which have not been of major interest in the prior ITA efforts--all of which were focused on traditional energy supply sources. In the planned studies, greater interest in population distribution, space heating and cooling, transportation impacts, etc., will require accurate projections in economic sectors which have not received the special attention given in the past only to heavy energy users or pollution generating industries.

An additional, more focused project is in the design stage within the ITA program. This project calls for the development of a modeling capability for use in analyzing the potential for and impact of industrial combustion of coal. This capability would be designed either as an integrated part of SEAS or as a separate but complementary model. In this project, a great deal of thought has already been given to the importance of regional economic projections and the geographic dependence of industry fuel choices for new facilities. The difficulty of modeling fuel use choices is increased by the regional variation in the physical properties and delivered price of coal.

The credibility of air quality analysis techniques in identifying areas in which emitted or secondary pollutants might create or aggravate environmental problems is of utmost importance. The credibility of this air quality analysis is, of course, partially dependent on the economic analysis techniques used to generate the geographic distribution of industry sources. Two memoranda from Barry Sedlick of Teknekron Research, Inc., are included with the workshop background materials. They discuss in more detail some aspects of these questions being considered in the current Industrial Boiler Model design activities.

DOE-OFFICE OF TECHNOLOGY IMPACTS

The Office of Technology Impacts (OTI) under the Assistant Secretary for Environment (ASEV) at DOE is responsible for assessing policies that allow DOE to develop energy programs with minimal adverse effects on human health and the environment. An assessment of the environmental conditions projected to result from future energy policies is necessary for ASEV to ensure that DOE energy programs will be compatible with environmental goals.

Within OTI, the Environmental Impacts Division is directly involved in the development, improvement, and application of SEAS. Current DOE efforts in the area of regionalization are concentrated on location of energy efforts in facilities. Future development efforts will concentrate on improving the overall structure of SEAS regionalization such that a wide variety of future assessment or modeling needs may be met. Improvement of the regional economic projection capability will be one of the areas included in the next DOE SEAS development plan currently under design.

In addition to national level assessments, DOE is involved in some more detailed regional assessments. The RIIA (Regional Impact Identification Analysis) program analyzes scenarios for given sets of economic and energy development conditions and investigates environmental and socioeconomic impacts at various regional levels. The national laboratories do detailed impact analyses for the six regions of the country. DOE has centralized the larger scale projection capability based on SEAS at DOE headquarters. Additionally, DOE is involved in doing generic technology assessments, for example, a solar assessment and coal utilization assessment. In the solar energy area, for example, EV is conducting a Technology Assessment of Solar Energy (TASE) to evaluate the long-range environmental and socioeconomic effects of widespread solar development in the United States. The project will assess impacts at the several geographic levels (i.e., national, federal region, state, Air Quality Control Region, Aggregate Subarea, community) by comparing the effects of a "low" solar development scenario with those projected under a "high" solar development scenario. The TASE is using SEAS for projection and analysis of environmental pollutants.

RESOURCE CONSIDERATIONS

Because of the timing of several key projects for which improved economic regionalization is crucial, measures which can be implemented in six months to two years are especially of interest. Also, the total EPA effort alloted to SEAS is limited. The level of effort available for improved regional economics over the time period in question is likely to be no greater than 2-3 person years. DOE's resources for this purpose may be slightly greater but probably not markedly so. Therefore, those recommendations which can be implemented in the desired time frame with a fairly small number of person years of effort will be especially attractive to both EPA and DOE.

This does, however, raise another question which should be addressed in the workshop. Is it possible to achieve the objectives which we have established for the regional economics component of SEAS--to credibly project regional economic activity at least down to BEA areas, reflecting regional differences in economic conditions and trends--with this level of effort, or with some incremental approach, the first stage of which would fit within these constraints? The answer to this question substantially impacts EPA and DOE strategies for SEAS development and the judgement of workshop participants on the question is desired.

Assuming that we can proceed with the currently-envisioned approach of incremental improvement, it appears that recommended modifications to SEAS would certainly be useful in at least three areas--the basic approach in the Region module, the "overriding" procedures for those economic sectors in which such procedures have or should be established, and regionalizing procedures internal to other modules for key sectors such as electric utilities, coal mining and possibly within the proposed industrial boiler model/modules.

In addition, EPA and DOE would be interested in any other recommendations workshop participants may wish to make concerning SEAS more generally, longer term modifications, etc., as these may prove useful in future planning and development efforts.

Currently in progress within EPA is a major comprehensive review of SEAS data bases and model structure. Within DOE a similar effort is being contemplated. It is hoped that this regionalization workshop will serve as one of the early major steps in this overall review process. Ideally, recommendations from the workshop can be used as a basis to design a joint EPA/DOE effort to improve the regional economic component of SEAS. This might then provide the first step in building a larger comprehensive joint development program.

An Evaluation of Current Regionalization Procedures in the Strategic Environmental Assessment System

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INTRODUCTION

The objective of this paper is to critique the current approaches and data bases used for regionalization in SEAS and to recommend some directions for improving regional forecasts. The paper consists of three parts. The first section traces the historical development of the current system and includes a discussion of the reasons some of the decisions regarding regionalization were made and their implications. The second section summarizes some of the principal weaknesses of the present scheme. The final section of the paper suggests an overall framework for improvement as well as a series of tasks that could be used as a preliminary workplan.

The term "regionalization" in SEAS has typically been used very broadly. It has been used to denote forecasts of regional economic activity including industrial output, energy supply and demand, regional population, and other variables. It has also been used in reference to regional environmental forecasts of such widely differing variables as air pollution emissions, land use, occupational safety and water use. In the latter context, it is recognized that the same level of economic activity in two regions can lead to different environmental impacts because of different local pollution control standards, difference in climate, population density, equipment vintage and other factors. Of the two broad contexts, however, it is the regional economic forecasts that are the principal focus of this paper.

THE CURRENT SCHEME: RATIONALE AND CONTEXT

The SEAS regional forecasts are based on a top-down approach. National forecasts of GNP, its composition, sectoral output and other variables are made first. Sectoral output (but not GNP) is then allocated to regions such as states, Air Quality Control Regions, Standard Metropolitan Statistical Areas, etc., using a mix of analytical techniques.

It is useful to briefly describe the steps in the forecast at the national level and to trace the regionalization techniques from a historical perspective. A modified version of the INFORUM input-output model is used to forecast output (measured in constant 1971 dollars) for each of 185 sectors of the economy.* Econometric equations are used to generate forecasts of the major components of final demand (consumption by product, investment by sector, etc.). An aggregate 185 x 1 final demand vector is derived using "bridge matrices" where necessary to allocate some of the final demand aggregates (such as investment) to final demand purchases from each of the 185 sectors. Forecasts of the input-output coefficients to account for material and product substitutions are made next and the Leontief system is solved for gross outputs.

Pollution forecasts are more easily linked to physical measures of output, such as tons of a particular chemical or Btu input of a fuel to a technology, than to dollar measures. However, the level of disaggregation in INFORUM is not detailed enough to distinguish among products and processes with significantly different residual coefficients (tons of pollutant per unit output). For these reasons, the forecasts from INFORUM are disaggregated into about 300 additional subsectors using functions of the following form:

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*In the DOE version 200 sectors and 1972 dollars are used.

$$\bar{X}_i = \sum_{j=1}^{185} \bar{A}_{ij} X_j + \sum_{k=1}^{m} \bar{C}_{ik} F_k$$

where

$\bar{X}_i$ is the production of a given good (say titanium dioxide) measured in quantities such as tons, Btu's, etc.

F_k is the kth component of final demand (e.g., consumption, imports, etc.); k=1, ...,m.

X_j is the constant dollar output of sector j (j=1..185)

$\bar{A}_{ij}$, $\bar{C}_{ik}$ are estimated parameters*

$\bar{X}_i$ is, in several cases, further disaggregated into the amounts that are produced by alternative processes:

$${}_{\ell}\bar{X}_i = \gamma_{\ell} \bar{X}_i$$

where

${}_{\ell}\bar{X}_i$ is the amount of the good produced by process ℓ

γ_{ℓ} is a parameter estimated for the base year and user-specified for forecast years.

The regional allocation of the values X_j, $\bar{X}_i$ and ${}_{\ell}\bar{X}_i$ in early phases of SEAS emphasized the development of a valid set of regional "shares" for the base year. In the process, the accuracy of forecast values was given less consideration than the base year data and the procedures subsequently used to remedy the weaknesses have significantly improved the forecasts in some sectors (primarily energy sectors) but not in others. Several weaknesses remain in the overall forecasts.

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*Note that each subsector is not a function of all sectoral outputs and final demands. The number of nonzero elements in $\bar{A}_{ij}$ and $\bar{C}_{ik}$ varies from one equation to another.

The national values of X_j, $\bar{X}_i$ and ${}_{\ell}\bar{X}_i$ for the base year were disaggregated using available data sources on county production of the good or proxies for these measures. In general, $\bar{X}_i$ and ${}_{\ell}\bar{X}_i$ were allocated to counties using information from trade directories, Department of Commerce, Department of Energy and other sources on base year production. The principal errors here arise from the use of data from variable years (1971 to 1976) to apply to 1971 national values, the use of capacity measures where production data was unavailable, and the occasional use of proxy measures such as population to allocate national production of a good where no reliable regional series was available.

A significant problem was present in allocating the Xj's or constant dollar outputs to regions. Census data on the value of shipments at a 4-digit SIC level contains major disclosure problems at a detailed regional level. Consequently, a 4-digit employment data base was used to allocate national Xj's, thereby assuming that regional shares of output are roughly equal to regional shares of employment. There are likely to be significant errors here since labor productivities in a given sector vary significantly across regions. There was also the problem of undercoverage of small firms in the employment file.* No attempt was made to control for these, however.

Another weakness relates to the forecasting procedures. No general interregional econometric or multiregional model was available in the initial development stages of SEAS. Conventional wisdom regarding regional activity in the future was best exemplified by the OBERS forecasts of the Department of Commerce and this still is used extensively in SEAS.

The regional forecasts of X_j, $\bar{X}_i$ and ${}_\ell\bar{X}_i$ were obtained by deriving growth-indices from the relevant OBERS sectors and multiplying the base year values by these indices. All INFORUM sectors and INSIDE subsectors which were a subset of a given OBERS sector (there are 37 OBERS sectors) used the same growth rate or index in a given region.** The resulting forecasts were scaled to meet national control totals. One feature of this scheme was that regional shares of national totals were, in this procedure, invariant across scenarios. The OBERS forecasts were, as the name implies, a forecast for a given scenario and not an analytical tool for making alternative forecasts.

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*The data base known as the Economic Information System file is best on its coverage for the larger firms. Very small firms (with less than 20 employees) are not covered.

**Thus, for example, the growth rate of iron ore mining will be the same as that of nonferrous ore mining.

This feature (the so-called permanent share file) was particularly unacceptable when SEAS entered a new development phase beginning with its use as the principal tool for the Department of Energy's Annual Environmental Analysis Report. The focus here was in analyzing the impact of various energy policies on environmental trends. To avoid the weaknesses inherent in the use of fixed shares, two new procedures were developed.

The first was simply an override option. Here the user specifies the regional shares exogenously, based on analysis of specific technologies or processes. These shares allocate the national production to various regions, particularly states. This method (called the manual share file) was used for several energy sectors and a few nonenergy sectors, thus providing a framework to avoid a sole reliance on the OBERS forecasts. The primary weaknesses of this approach were (a) that it was difficult in practice to generate a new set of shares for each scenario (many of these share files have also been scenario-independent); (b) while it was feasible to specify a share file for regions such as states, it would clearly have been a major effort to specify shares for all regions such as AQCRs, ASAs, etc., so that some flexibility was lost; (c) shares were specified on a sector-by-sector basis--interindustry linkages at a regional level were not considered.

The second regionalization extension was the development of special modules for important sectors such as electric utilities, industrial boilers and coal mining. The principal feature of these modules was the specification at a county level of where facilities were likely to start operation in the near- to mid-term (1 to 10 years) based on criteria such as environmental constraints, industry plans and other factors. Because these facility sites were rank-ordered along a time dimension, it enabled the shares to be scenario sensitive and, since they were county based, they could be aggregated to any desired regional level.

Another feature of the new modules was a linkage of the modules' forecasts to those of other regional energy supply and demand modules, particularly the Department of Energy's Midterm Energy Forecasting System (formerly PIES).* These other energy models were used to forecast energy supply/demand at the Federal regional level with SEAS providing the framework for the more detailed forecasts of energy activity at AQCR, states and other regions. These activity forecasts, combined with residual coefficient data, yielded residual trends.

AN ASSESSMENT OF THE MAJOR WEAKNESSES

There are two types of criticisms that can be directed against the current system; these relate to the analytical approaches and the data bases respectively. Both of these are discussed in this section.

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*A simpler version of the analytical methods incorporated in some of these special modules is the "dynamic" regionalization process in which counties are rank-ordered with an estimated production assigned to each county. A fixed share file is used to allocate any national production that is not met from this rank ordered list. In this process no internal constaints or regional balancing are imposed.

Problems Related to Sectoral Aggregation

A simple feature about the system needs to be emphasized before proceeding further: the "regionalization" of sectors at various levels in the hierarchy -- INFORUM, INSIDE product level, INSIDE process level and energy sectors -- are essentially done independently. If the user specifies an "override" on the regional shares for a given INFORUM sector, he should be aware that the override does not affect the regional product level forecasts (which are measured in tons). Or if he imposes an override at the product level, it will not carry over automatically to the INSIDE process or INFORUM sector level. Likewise, if he makes different assumptions about regional production regarding one part of the cycle, e.g., coal mining, this does not affect any other part of the cycle, e.g., coal preparation. The consistency across sectors is essentially handled at the national level, not a regional level.

The consistency question can perhaps best be illustated by means of an example. Consider a good that can be produced by two processes, X and Y. Assume also that while process X is the dominant one in the base year with respect to share of total national production (measured in tons), process Y is expected to gain the major share of the market by 2000. Assume further that, in the base year, four regions (counties, for example) produce the given item and that their respective shares are given as

	Base Year		Total
	Process X	Process Y	
County 1	100 units	50 units	150
County 2	500 units	10 units	510
County 3	5000 units	-	5000
County 4	600 units	-	600
	6200 units	60	6260

That is, two counties have capacity in both processes, while the (new) process Y has yet to penetrate the market in Regions 3 and 4. By 2000 it is assumed that national production of the good will increase from 6260 to 10,000 units and that 7,000 units will be produced using Process Y. The methodology in SEAS will allocate all the production of Process Y to Regions 1 and 2 since these were the only two regions that had any base year production. Their base year production would be "shifted" over time based on corresponding 2-digit OBERS growth (decline) rates and then scaled to meet national totals. An even more extreme case of the example would arise if, at the national level, only process Y were assumed to be used by 2000. In that case, counties 3 and 4 would in the current methodology be estimated to lose their productive capacity for the good entirely. In fact, of course, what would probably happen is a shift by all regions to the more attractive technology or process, with some regions gaining more than others due to locational advantage, aggregate regional activity or other reasons.

Related to the above problem is one that can be referred to as an "adding up" problem. Consider the aggregate level of production of the product in question in Region 1. In the base year this is 150 units -- or about 2 percent of national capacity. Given the structure of the overall model, it is extremely likely that, for a given product, some pollutants (say, air residuals) are being computed using _process_ detail, while other residuals (e.g., water residuals) are being computed using INSIDE _product_ or INFORUM sector detail. Thus, in Region 1, air residual coefficients might be in terms of _total_ production regardless of process. Conceptually this causes no problem and would yield correct values for the base year assuming no errors exist in the data base.

For the forecast let us assume that all the relevant counties are in the same state and therefore have the same 2-digit OBERS growth rate. Let us further assume that this growth rate is 2 percent a year. These growth rates would, at the _product_ level, be applied to the figures in the 'Total' column in the above table. After the growth rates are applied, the resulting regional values for the year 2000 would be scaled to meet national totals -- 10,000 units in the example. Clearly County 3 would be the dominant producer. However, we argued earlier that County 3 would gain no new production of process Y and its use of process X was declining because of declining national production using that process. In fact, if we examined the _process_ detail in the forecasts that is exactly what we would find for County 3. The sum of the parts (processes) does not equal the whole (product). We have an "adding-up" problem and resulting inconsistency in the forecasts of different pollutants for the same good in a given region. Since, for a given good, pollutants are potentially calculated at three levels -- INFORUM sectors, INSIDE product sectors and INSIDE process sectors -- such inconsistencies may not be inconsequential. And the problem cannot easily be resolved by estimating all residuals at the most detailed level. First, there are significant data issues that constrain the level at which coefficients are defined. Coefficients for water use and occupational safety can -- in many cases -- only be estimated at the INFORUM sector level using census data at the 4-digit SIC level while others (air or water residuals) are best defined at a product or process level. Secondly, the regional economic forecasts can be in significant error as the level of disaggregation increases. (How do we decide what the market penetration of process Y should be in County 3?) The "adding-up" problem has no easy solution.

Consistency Problems Related to Use of Proxy Variables

As explained in Section 1, different variables are used in the estimation of regional production. First, regional employment is used to allocate production for all INFORUM sectors in the base year. Since regional productivities can differ significantly, such a procedure would result in overestimates of residuals (for the base year) for regions with lower productivities than the national average. This is true for those residuals calculated at the INFORUM sector level.

Secondly, the OBERS earnings forecasts are used to "shift" the base year production, implying that changes in regional 2-digit earnings shares are identical across all (INFORUM) sectors within a given 2-digit sector. It also implies that shifts in output are proportional to shifts in earnings. The "reasonableness" of this assumption should be tested on historical data.

Lack of a Comprehensive Picture of Regional Economic Activity

Different measures of sectoral activity are not consistently related to each other. For example, regional population shares are derived from the OBERS forecasts and, while they change over time, they remain constant across scenarios. Variations in regional energy production, for example, have not been related to population nor have the factors affecting migration been evaluated in the model.

Similar comments apply with regard to regional employment. Interest in regional employment forecasts has been increasing, partly due to the national trends in productivity growth, energy policies that result in excessively rapid growth in some regions as well as known or suspected relations among environmental policies, industrial location, and jobs created or lost. A methodology to analyze these trade-offs is clearly needed.

Weaknesses in the Linkage of Energy Demand, Supply and Regional Activity

As currently structured, the system cannot adequately estimate the regional economic impacts of changes in energy supply activities. Consider, for example, a major synfuels program with locations of plants concentrated in the Western regions. Such a program would result in direct, indirect and induced economic effects with accompanying environmental consequences. The direct environmental effects are captured in a straightforward manner through multiplying the measure of energy output (e.g., Btu's of coal mined, Btu's of synfuels produced) by residual coefficients to derive direct environmental effects.

The only direct measure of economic activity here are Btu's of energy output. Direct regional employment, either in the construction or operational phase, is not estimated. More importantly, from the viewpoint of environmental effects, the regional system does not endogenously capture indirect economic effects such as the additional employment in the materials supplying industries or any of the induced effects resulting from income generated, such as higher levels of consumption and the accompanying employment. Supply industry effects are captured in the national model but, since regional shares of INFORUM sectoral output are static across scenarios, the Western regions would, in the example given, not gain a reasonable share of the incremental production. This would lead to underestimates of residuals for the region in supply sectors as well as transportation emissions and others affected by aggregate regional economic activity.

On the demand side, both the electric utilities and industrial boilers module have made a significant contribution in understanding the role of these sectors in aggregate emissions, as well as in helping assess the impacts of various policies such as variations in

NSPS standards on trends in regional emissions. One of the remaining weaknesses is the somewhat rigid relationship between regional forecasts of fuel use in utilities and boilers and regional industrial output. "Shifts" in aggregate manufacturing activity from the OBERS forecasts have been used as one independent variable affecting growth in electricity supply and boiler activity. There are two problems here. First, rates of growth or decline within manufacturing sectors have not been considered. Second, with regard to utilities such a procedure fails to recognize possible trends toward minemouth generation that would result in a divergence over time between the location of electricity supply and demand. Moreover, there is the continuing problem that OBERS "shift" factors are invariant across scenarios. And if the user chooses to manually impose a different scenario regarding location of key industries, this would, under the current system, not be input to the utilities and boiler modules, implying inconsistencies between the process residuals and energy related residuals from the same sector.

Consistent Growth-Indices Across Regions

One weakness regarding the way OBERS is used needs note. The "state" level growth rates are derived from a special OBERS run completed in 1978 for EPA. However, the growth rates for other regions are derived from the earlier OBERS study published jointly by BEA and the Water Resources Council. The two sets of forecasts differ at both the national as well as a regional level resulting in forecasts at the SEAS sector level that are not consistent across various regional groupings. For example, the forecast for the pulp mills sector in the Northeast would differ if derived by summing across states than if it were derived by summing across BEAs. Finally, OBERS forecasts were not made for AQCRs. Here a crude procedure was used to derive growth indices for an AQCR based on OBERS forecasts for SMSAs and non-SMSA parts of BEAs. The error here is significantly less than one would expect, since AQCRs are primarily used for air pollution analysis and the most important sectors here are utilities, boilers and transportation, for all of which special modules exist with regional controls given from sources other than SEAS.

SUGGESTIONS FOR IMPROVING THE STRUCTURE

This section contains two sets of recommendations. First, a series of validation tests and simple improvements to the data base are described. And secondly, a more comprehensive approach of rebuilding the regional structure of SEAS is proposed.

Short Term Changes

Many simple tasks can be formulated to test the validity of the current structure. Examples of these are listed below:

- The county employment file in SEAS that is used as the basis for base year regionalization at the INFORUM sector level should be compared to Census, BEA and BLS series on employment. Both regional and industrial aggregation may be necessary, but this is a simple task.

- The assumption that employment is a good proxy for value of shipments should be tested by comparing values estimated for the base year. The implications of errors on residuals designated at the INFORUM sector level should be analyzed.

- The assumption that OBERS earnings growth rates are a suitable index to "shift" base year regional shares should be tested by comparing the regional shares currently estimated in SEAS for 1977 to shares derived from the 1977 value of shipments (after purification from an establishment to a product basis as in INFORUM). If necessary, 1977 Census data should be used as controlling totals. Earlier Census data, e.g., 1967 or 1962 could also be used.
- The error referred to in the "adding-up" problem discussed in the previous section should be examined by estimating regional production (tonnage) data from other sources for 1977 for a few key products and processes and comparing them to those being forecast within the system.
- The implications of not linking energy demand directly to sectoral activity and population within SEAS should be evaluated by listing forecasts in different ways (e.g., Btu's of residential use of energy per capita, etc.) and comparing the forecasts with recent trends.

These and dozens of other tests can be devised to improve the current system in the short term. A longer term picture is discussed below.

Development of a Core Regional Econometric Model for SEAS

A survey of the literature indicates several dozen models have been developed in the past decade for purposes of forecasting regional economic growth. Table 1 lists some of the principal ones that forecast economic activity for regions that cover the United States (e.g., all states, all counties, all BEAS, etc.).

Analysis of these models suggests that they can be divided into three categories. First, there are models that rely entirely on behavioral equations based on time series and cross-section data and are extensions of the early single region models of L'Esperance, Crow, Glickman and others (Table 2). Next, there is the pioneering

Table 1

Partial List of Comprehensive Regional Models of the U.S.

1. Comprehensive Regional Models of the U.S.

Author (Reference)	Regional Delineation
Bureau of Economic Analysis	50 States + District of Columbia
Chase Econometrics	50 States + District of Columbia
Mathematica - Comprehensive Human Resources Data System (King 1977)	50 States + District of Columbia
Data Resources, Inc. - State Area Forecasting Service (1977)	50 States + District of Columbia
Oak Ridge National Laboratory-MULTIREGION (Olsen 1977)	173 Economic Areas defined by the Bureau of Economic Analysis
Federal Energy Administration - Regional Energy Activity and Demographic Model - READ (Donnely 1977)	County Level
Federal Energy Administration - Regional Earnings Impact System - REIS - (U.S. DOE 1976)	50 States + District of Columbia
Polenske - The Multiregional Input-Output Model (1970)	50 States + District of Columbia
Golladay and Haveman: Regional Impact and Distribution Model (1976, 1977(a), 1977(b))	23 Regions (aggregations of states)
Stevens and Treyz	States*

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*The model has only been estimated for Massachusetts thus far.

TABLE 2: Partial List of Regional Modelling Efforts

1. State Models

State	Author (Reference)
California	Burton, et al. (1965)
Hawaii	Licari, et al. (1973)
Massachusetts I	Bell (1967)
Massachusetts II	Friedlander, et al. (1975)
Michigan	Research Seminar, University of Michigan (1965)
Mississippi	Adams, et al. (1975)
New York	Wharton Econometric Forecasting Associates
Ohio	L'esperance (1975)
Pennsylvania	Klein, et al. (1975)
Puerto Rico	Dutta, et al. (1969)
Washington State	Bourque, et al. (1977)

2. Multi-State Models

Region	Author (Reference)
Northeast Corridor	Crow (1969)
New England	Wharton Econometric Forecasting Associates
Coastal Plain States	Richter (1970)

3. Other Regional Models

Region	Author (Reference)
Buffalo SMSA	Crow, et al. (1974)
Cleveland SMSA	Loxley (1976)
Luzerne County	Schink (1974)
Philadelphia SMSA	Glickman (1971)

work of Polenske and her colleagues on multiregional input-output models. And finally, there are some models that attempt to bridge these two trends and incorporate a mix of input-output and time series analysis.

A core regional model for SEAS could conceivably center around any of these basic approaches, though some are likely to be more cost-effective than others. There are several characteristics that are desirable, however, that need to be emphasized.

First, the core model must be capable of being linked to a variety of national models, including INFORUM. This would enable the analyst to evaluate the effects of various national policies on regional economies.

Second, the factors affecting the location of industry must be explicitly identified. Factors affecting industry location should include energy, labor, taxes, national input and environmental control costs. Where data permits, the substitution among these inputs should be estimated endogenously in the model.

Thirdly, the core model should be capable of being linked to a variety of (satellite) modules of the type incorporated in SEAS, including

- Sector disaggregation by process
- Energy demand and supply
- Emissions of pollutants

It is important to note that the model would not be a recursive one. Various policies (including economic and revenue policies) could be directly input into the satellite models and the results of these models affect regional activity forecasts of the core model. An example of such a policy simulation would be an analysis of the effects of constructing new energy facilities (e.g., solar facilities, synfuel facilities) in any region. The effect of these on energy demand and supply balances would be analyzed in a satellite module but the total (direct and indirect) effect on sectoral employment, income and population would be analyzed in the core model.

In summary, the core model would provide several advantages over the current SEAS structure. It would provide a consistent framework for analyzing the relationship between industrial activity, population, energy demand and environmental effects. It would be sensitive to policies enacted at both the national level as well as the regional level. It would be based on significantly greater degrees of freedom than the current structure -- the current regional structure has few behavioral equations -- thus, error analysis would be feasible.

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Improving The Region Module of SEAS:
Suggested Approaches and Potential Problems

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INTRODUCTION

Other papers describe how SEAS currently regionalizes both economic activity and environmental residuals, and the needs foreseen by the Environmental Protection Agency for conducting strategic analyses and related studies. This paper is one of several which suggests possible modifications to the model to improve SEAS' regionalization capabilities. It discusses the current status of regional data in SEAS and suggests development strategies, both short term ones for modifying the existing regionalization approach taken in the model and longer term efforts for changing the basic structure of the regionalization component of the model, for making SEAS more sensitive to OEMI/ORD needs.

AN EVALUATION OF THE SEAS REGIONALIZATION MODULE

Regionalization methodologies for disaggregating national economic and environmental projections have been described in other papers and will not be repeated here. However, it would be useful to begin by discussing the strengths and weaknesses of the REGION module as it now exists to identify those areas where model development and enhancement should be undertaken.

Clearly, the outstanding characteristic of the regionalization approach taken in SEAS is that it uses the county as the basic geographic unit of analysis, i.e., all regional shares in SEAS result from county-level aggregation procedures (which are subsequently modified by growth rates developed from OBERS regional projections).

The strength of this approach is that since the county is the fundamental building block for most other regional definitions, and therefore county boundaries retain their integrity in virtually all other regional definitions, then county-level information in the data base allows the specification of all other geographic units through error-free aggregation procedures.

Thus, SEAS is capable of providing at least base-year information at the following geographic scales:

- county
- minor river basins
- major river basins
- aggregated sub-areas (ASA)
- BEA regions
- standard metropolitan statistical areas (SMSA)
- non-SMSA portions of BEAs
- air quality control regions (AQCR)
- states
- federal regions.

This flexibility provides SEAS with capabilities for comprehensively analyzing a broad range of environmental and energy policy issues and partially addresses the analytical needs of the Agency as outlined in a previous paper.

However, the county-level basis of SEAS also carries with it major weaknesses which must be recognized in a model application.

A principal shortcoming lies in the consensus that county-level data are probably the least reliable of all geographic accounting units used to collect economic and environmental information. Problems associated with county-level data are primarily statistical and are related to small sample sizes in surveys at this geographic scale. Institutional factors such as government disclosure regulations also contribute to reliability problems with these data. Furthermore, fewer parameters of economic activity are collected at the county-level.

It should be noted that the county, as the fundamental unit of analysis for projecting impacts, was a major criticism of the Energy Information Administration's READ model in the peer review of the model undertaken last year. (Two reviewers did find the geographic scale acceptable, however.) And although county-level information in SEAS is usually aggregated to other regional units to produce more reliable estimates, anticipated applications requiring more detailed regional projections and further development efforts toward ambient environmental quality indicators can be expected to place significant demands upon SEAS' county-level information base.

Other weaknesses may be associated with the regionalization methodology as well, which relate to the way in which regional shares are forecast in SEAS.[1] As described in other papers, OBERS projections are used to develop a set of growth indices for extrapolating regional shares into the future. Regional shares for all geographic units except counties are estimated for 1985, 1990, and 2000 by multiplying the base-year value by the corresponding OBERS regional growth index. In most cases, correspondence between OBERS and SEAS regions is exact, although in some, such as AQCR's, a composite growth index must be fabricated from OBERS projections. This latter problem is likely not a significant source of error in share projections. Note also that county-level shares are not projected in the SEAS data base.

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[1] This paper does not address the quality of regional OBERS projections generated by BEA.

Two problems are associated with the share forecasting methodology. One is that OBERS projections are made at the 2-digit SIC level and are based upon historical trends established over a decade ago which do not account for post-embargo economic conditions, observed demographic shifts and environmental regulations which have taken place more recently. Only state-level shares have been updated with more recent projections developed by BEA for EPA.[1] These projections have been found to be significantly different from earlier OBERS forecasts, particularly in Northeast and Sunbelt states. Regional shares for other geographic units therefore fail to incorporate these fundamental changes in economic and demographic structure and are inconsistent with state share forecasts. A second problem is that since a strictly top-down methodology is used to construct shares and only a single exogenous projection is used to calculate growth rates, regional shares at all levels of aggregation are scenario insensitive. SEAS is intended to estimate the environmental consequences of alternative economic and energy futures and the absence of sensitivity in the regionalization component of the model to changes to energy and economic parameters which characterize these futures is clearly a weakness which should be investigated.

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[1] Bureau of Economic Analysis, Population, Personal Income and Earnings by State: Projections to 2000. Unpublished manuscript prepared for Office of Water Program Operations: U.S. Environmental Protection Agency by the Regional Economic Analysis Division, U.S. Department of Commerce, Washington, DC, October 1977.

Some of these problems have been at least partially addressed in development efforts undertaken by SEAS contractors. For example, scenario-sensitive regional shares may be exogenously specified and entered through the manual and dynamic override files, and three special regionalization modules which address environmentally important sectors of the economy (electric utilities, industrial fuel combustion, and coal mining) have been developed.

However, the fundamental characteristics of the regionalization data base remains the same. The basic geographic unit of analysis remains the county. Given the tendency towards analyses at finer and finer levels of resolution and the types of issues likely to be addressed by SEAS in the future, a reevaluation of the regionalization module in terms of data quality and scenario sensitivity would appear to be appropriate.

THE CURRENT STATUS OF REGIONAL DATA IN SEAS

Most base-year regional economic data in SEAS have been developed from 1972 information. These data, derived from employment surrogates, were developed from the EIS data base, one of the more comprehensive inventories of U.S. industrial activity. Additionally, selected sector and subsector shares have been updated to 1976 using primary sources, such as industrial directories. County-level detail generated by the electric utilities, industrial combustion and coal mining modules is based upon post-1975 data. Data sources and their vintage have been extensively documented in a memo by Watson (1977).

Although regional data which comprise SEAS share files have been qualitatively assessed in various papers and applications, no comprehensive validation efforts have been recently undertaken on the SEAS data base. Watson (1977) suggested permanent share file updates for several industrial sectors and alternative data sources for creating regional shares in her 1977 paper. Most of these suggestions have not been implemented. Regional estimates of economic activity and pollution emissions from the electric utilities, industrial boilers and coal mining modules are based upon more recent data which are specific to the processes being modeled. Base-year shares estimated in these modules can therefore be considered reasonably accurate and further validation of base-year data would not appear necessary at this time. Similar conclusions can be reached regarding regional data in the dynamic and manual share files.

Clearly, the set of regional data most in need of validation is the permanent share file of the REGION module. Because of the Department of Energy's emphasis upon pollution generated by energy extraction, conversion and consumption, regional shares of economic activity by most other INFORUM/INSIDE sectors are the most out-of-date and need to be reassessed. However, before resources are spent on data base development, a comprehensive validation of regional shares in the permanent share file should be undertaken.

The validation effort should first determine which industrial sectors/subsectors in the permanent share file are most important from an environmental standpoint, and second, at which geographic scales regional information is most critical. To reduce the scale of this effort then, validation should attempt to evaluate the accuracy of base-year (1975) share data at the most relevant geographic scales for only those sectors/subsectors found to be environmentally significant. Such an effort is necessary particularly if short term improvements to the regionalization component of SEAS are to be made.

In proposing ways to improve SEAS' REGION module, contraints on model development efforts must also be recognized. The major technical constraint concerns the methodology itself. The SEAS REGION module employs a top-down methodological approach which, for all intents and purposes, must be retained in any further development efforts. The bases of SEAS are national ones relating economic growth assumptions with energy supply and demand assumptions.

Consistency with national projections is therefore a binding constraint which must be satisfied.

However, a second constraint which must be recognized is that any regionalization development efforts must contribute to satisfying EPA's stated needs (and at least be consistent with those of DOE). Although this constraint may appear obvious, it cannot be emphasized too strongly. EPA requires a regionalization module which is capable not only of allocating sectoral economic activity but also recognizes potential process shifts and the locations where these changes can be expected to occur. Prime examples of the latter include steel and pulp and paper manufacturing activities. EPA further requires a regionalization component which is sensitive to national scenario assumptions so that alternative regional scenarios can be assessed in terms of their environmental implications. Such capabilities would appear particularly relevant in planned integrated technology assessments (ITAs).

POSSIBLE IMPROVEMENTS TO THE REGION MODULE

Both short and long term development efforts can be suggested for the regionalization component of SEAS. Short term improvements involve primarily the revision of regional shares in the permanent share file, while longer term improvements concern the revision of the methodological under-pinnings of the REGION module itself.

Many short term improvements which can be implemented relatively easily relate to suggestions made by Watson in her 1977 memo and involve data updating and incorporation of data from alternative information sources.

(i) Data Updating: There is clearly a need to bring regional share information up to at least a 1975 base-year. Environmental projections used by EPA in the Annual Environmental Outlook, in its Integrated Technology Assessments and in regional briefings all assume 1975 as the base. Furthermore, the electric utilities, industrial boilers and coal mining modules are 1975-based. Consistency considerations would therefore dictate bringing environmentally-important sectors/subsectors up to date. In addition, such an update would bring base-year information into a post-embargo time-frame and, further, would render regional share information consistent with national projections which are calculated to historical data for 1975. Such an update would also allow the incorporation of better data (if it exists) either from selected primary sources or other alternatives to output surrogates developed from the 1972 EIS file.

A major issue to be resolved if data updating is undertaken, however, relates to geographic scale. Since the REGION module is county-based, most regional data development efforts in the past have traditionally been proposed in that geographic context. This approach has restricted the kinds of data available for updating share files to a small number of sources and few variables. An alternative approach is to selectively update regional shares at the geographic scales where data are "best", e.g., if reliable data for a given sector/subsector exist at, say, the BEA level, then incorporate these data into the BEA permanent share file. Problems with this approach which can immediately be identified are two. First, selective updating only partially improves the regional data base; updating of any but county-level files precludes the mapping of these data to other regional units in SEAS. Thus, regional shares at different geographic levels may no longer be consistent. Second, selective updating of several files for a given sector/subsector could substantially increase the level of effort required to improve the permanent share file. Whether the benefits of incorporating information at alternative geographic scales are greater than associated costs should be investigated.

(ii) Alternative Information Sources: The updating of share data to a 1975 base-year will necessarily involve the investigation of alternative information sources for developing reliable regional information. This investigation must consider several factors which affect the amount of error likely to be embodied in regional shares. One of these is SEAS sector/subsector compatibility with sector definitions in regional economic data sources. The current county-level data base was derived from the 1972 EIS data file which lists over 115,000 industrial establishments by name, address, location, 4-digit SIC code and employment. Watson has claimed that accuracies of regional share estimates for several subsectors in SEAS are low because industrial classifications used to develop the shares are poorly correlated with SEAS sector/subsector definitions. Alternative information sources should therefore be evaluated in terms of sector compatibility with SEAS.

A second factor concerns the type of information available from alternative data sources. Since pollution emissions are most closely related to sector/subsector output, this variable should be used to develop the most accurate set of regional shares. However, output data (except possibly from primary sources) are rarely available for small geographic units and surrogates must be used. In the current regionalization data base, for those subsectors where EIS data are used, employment is the proxy for regionalizing industry. In other sectors, population is used to disaggregate national output to the county-level. However, little research has gone into determining which economic parameters best characterize economic output for given subsectors and it is suggested that part of the validation effort proposed for the REGION module concentrate upon this issue. Clearly, the number of parameters for regionalizing economic data to the county level is small, but sufficient information may exist for developing several surrogates to apportion national output to countries. (Dun and Bradstreet data cited by Watson (1977) reports both employment and sales volume by establishment; primary sources often give capacity estimates, etc.) Obviously, regional projections would be enhanced by using the best of these surrogates.

In addition to base-year data modifications, regional share projections in SEAS can be improved over the short term by incorporating new OBERS projections which are soon to be released by the Bureau of Economic Analysis. BEA is developing projections for 58 sectors of the economy (2-digit SIC) for several regional definitions from which revised growth rates may be estimated and applied to base-year shares in SEAS. Since these projections are expected to better reflect post-embargo economic conditions and other growth trends fostered by environmental regulations and regional activity than current OBERS projections, revised share projections in REGION will considerably enhance SEAS' regional forecasting capabilities. Further, greater sectoral disaggregation in new OBERS projections will allow more precise mappings of OBERS sectoral growth rates to SEAS subsector definitions, thereby reducing (somewhat) the magnitude of error usually introduced during this operation. Some problems can be anticipated however, as projections for water resource areas have been eliminated. Thus, surrogate growth rates, similar to those developed for AQCR regions, will have to be constructed for ASA and minor and major river basin regional projections. Regardless, improved regional share forecasts can be easily affected through the incorporation of updated OBERS projections for BEA.

However, short-term improvements to the regionalization component of SEAS can be considered to be only a partial response to addressing the environmental forecasting needs of EPA. Although supplying more accurate base-year regional detail and share projections, these modifications fail in several respects. For example, regional shares in the permanent share file are still scenario-insensitive. Alternative growth trajectories for the national economy or energy consumption and production, such as those presented in the 1980 Environmental Outlook, cannot therefore be properly translated into their true regional dimensions. This insensitivity extends to the regional scale as well. Alternative pricing, leasing or other policy decisions which may be of interest to federal region, state or other political constituencies cannot be effectively implemented through the REGION model as it now exists. This latter problem considerably reduces the usefulness of SEAS for providing analytical support in ORD activities such as regional briefings or OEMI integrated technology assessments.

To provide a forecasting framework capable of truly addressing regional environmental issues will require a basic restructuring of REGION and structural changes must be the approach of long-term development efforts for SEAS. A conceptual framework for defining this development effort is shown in Figure 1. The major enhancement to the regionalization procedure as shown in the diagram is the regional economic model, which is intended to more precisely characterize regional economic responses to changes in national economic activity. Note in this conceptualization, that the top-down

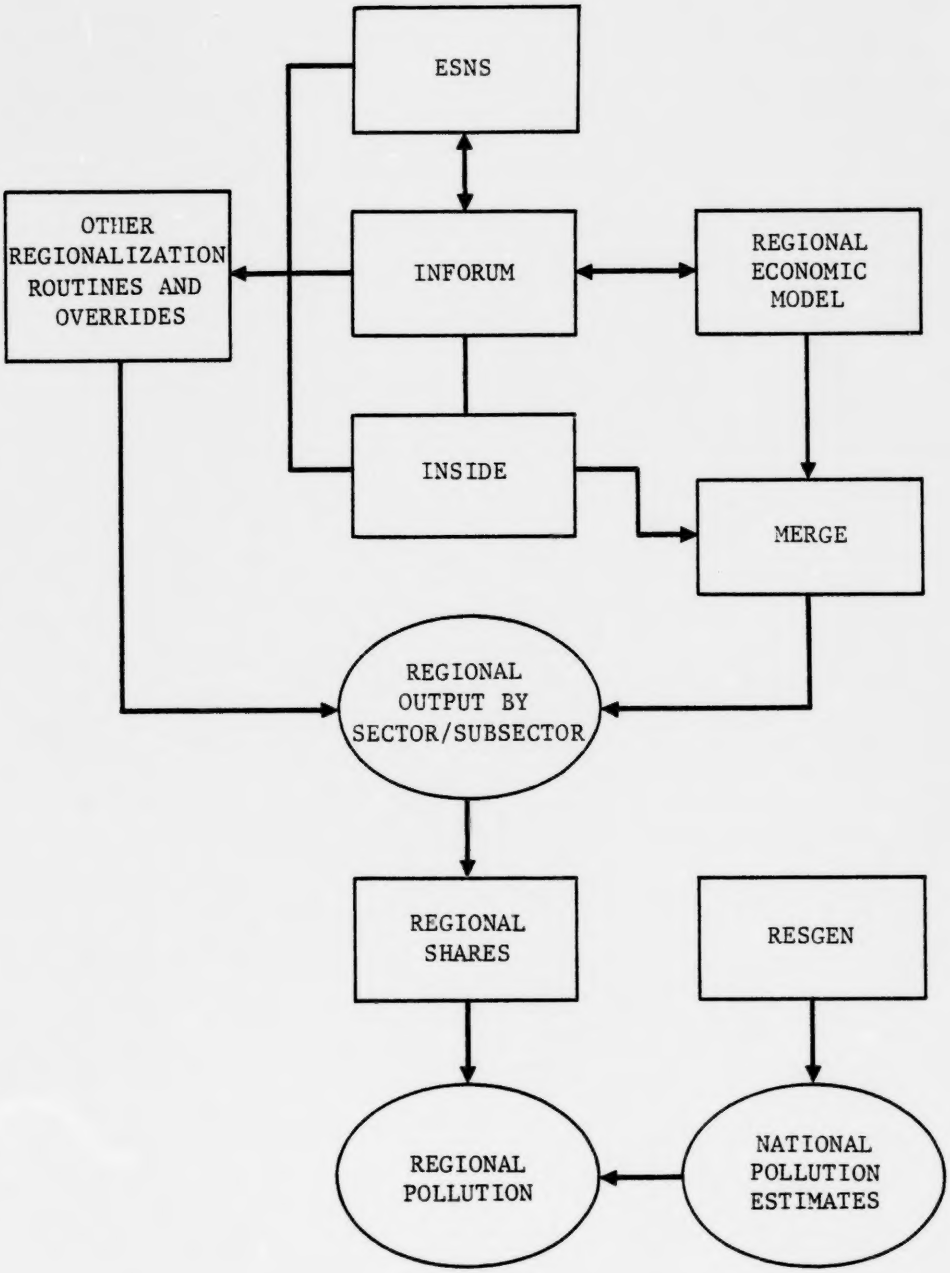
ESNS
OTHER REGIONALIZATION ROUTINES AND OVERRIDES
INFORUM
REGIONAL ECONOMIC MODEL
INSIDE
MERGE
REGIONAL OUTPUT BY SECTOR/SUBSECTOR
REGIONAL SHARES
RESGEN
REGIONAL POLLUTION
NATIONAL POLLUTION ESTIMATES

FIGURE 1
CONCEPTUAL FRAMEWORK FOR AN IMPROVED REGIONALIZATION METHODOLOGY

approach to regionalization is retained although provision is also made for feedback effects from regional to national levels.

Clearly, by incorporating a regional economic model for developing regional shares, many of the shortcomings of the current regionalization procedure of SEAS are overcome. The improvements can be considered both substantive and theoretical. With regards to the former, a regional model provides both national and local policy sensitivity for better addressing the kinds of issues currently analyzed in the SEAS modeling framework. To the latter, a regional economic framework which is based upon the determinants of sectoral and spatial growth and decline, and which explicitly recognizes the interdependencies among regions, provides a much needed behavioral rationale for the regionalization component of SEAS. Environmental projections are clearly more defensible when this behavioral basis is established.

However, the technical issues which must be resolved before these long-term improvements can be made are many. They relate both to the characteristics of the regional model chosen for incorporation into SEAS and to the task of integrating this regional framework into the overall modeling system.

(i) Choice of Regional Model: Precise specification of the linkages between REGION and other SEAS modules is, of course, highly dependent upon the regional forecasting framework developed for SEAS. And several multiregional models currently in existence can be considered for the regionalization component. Furthermore, the option exists for developing a new multiregional framework. The choice among alternatives will depend upon the resolution of the following issues:

Geographic Detail - geographic detail in multiregional models varies from county (Harris, 1973), through BEA (Harris, 1974; Olsen et al., 1977), state (e.g., Ballard, 1978; Chase Econometrics, Inc., n.d.) to federal region (Milne, Glickman and Adams, 1978). We have seen that projections for alternative regional definitions used by SEAS are most easily developed from county-based data but that data reliability problems are most severe at this level. On the other hand, complex region-to-region mappings (which themselves could incorporate significant error) may have to be constructed if another, more aggregate geographic unit is used as the basis for regional projections.

Sectoral Detail - greater sectoral detail in the multiregional framework is important because it can be expected to reduce problems associated with integrating INSIDE product and process detail into regional projections. INSIDE coefficients are national ones which are presently applied to INFORUM dollar output projections to derive physical product or process output estimates. The integration of these data with regional output projections is anticipated to be a major problem in regionalization development efforts, as uniform application of INSIDE coefficients to regional output estimates can be expected to introduce significant error into regional product/process estimates. Error is likely to be reduced if product/process splits are keyed off a sectorally-detailed multiregional model.

Compatibility with INFORUM - the conceptual framework outlined in Figure 1 assumes that environmental projections are based upon national residual coefficients which are applied to output projections from INFORUM/INSIDE before being regionalized, i.e., regionalization of environmental projections occurs after national pollution estimates are made. Since residual coefficients conform to INFORUM/INSIDE sector definitions, compatibility between regional and national economic models is essential if reliable regional residual estimates are to be made.

(ii) Integration with SEAS: The proposed integration of the multiregional model as shown in Figure 1 is intended to retain the basic overall structure of the SEAS forecasting framework. The multiregional model, as conceived in this paper, simply provides a more defensible regional allocation methodology than currently used OBERS-projected share files. That the economic and environmental components of SEAS are not totally restructured to accommodate the new regionalization framework creates several problems in this integration task.

The major problem has already been briefly discussed. The current share files in SEAS contain regional shares for most of the 185 sectors and 364 product/process subsectors which are accounted for in the model. Obviously, no multiregional model disaggregates the economy to this level of detail and the problem is how to translate the regional shares which are estimated by the multiregional model into shares for all sectors and subsectors in SEAS. Presumably, sectors in the multiregional model are aggregates of sectors and subsectors in SEAS (and hence the need for compatibility). Given the current information base, shares for all currently defined sectors/subsectors could be developed in one of two ways. In one, national product/process splits could be applied to regional output estimates (from the multiregional model) to arrive at regional subsector output projections. However, regional variations in production technologies and products would not be recognized by this method and considerable error would be introduced. A second methodology would retain the current regional shares for all subsectors not explicitly modelled by the multiregional framework, thus overriding share estimates for only a subset of industrial activities considered by SEAS. Problems of consistency and lack of scenario sensitivity make this an undesirable alternative. Since neither of these approaches appears feasible, considerable effort is likely to be necessary to integrate a new regionalization methodology into SEAS which is capable of utilizing the extensive environmental data base of the model (which is tied to INFORUM/INSIDE).

A second issue of integration concerns the other regionalizing modules of SEAS and special share files for emerging energy technologies. The regionalization approach currently taken in SEAS is "modular" in the sense that shares for particular technologies -- electric utilities, industrial boilers, coal mining, emerging energy technologies, and other selected sectors -- are each estimated independently of the other and from the majority of share data stored in the permanent share file. Although severe problems of consistency can arise from this approach, it can be argued that county share estimates from these independent modules are superior to those in the permanent share file because of better data, scenario sensitivity, etc., and these advantages override consistency concerns.

An improved regionalization routine which incorporates a scenario-sensitive multiregional model weakens these arguments, however. A well-specified multiregional model provides a behavioral rationale for allocating economic (and thus environmental) activity among regions. And while the special regionalizing modules may implicitly reflect behavioral economic decisions, explanation of inconsistencies becomes more difficult, and calibration procedures for reconciling regional forecasts should be considered.

Clearly, the severity of these problems is dependent upon the regionalization model chosen to improve the REGION module of SEAS, and most issues will not be totally resolved until this choice is made. However, the problems outlined here, and others raised at this workshop, should serve as guides in designing a new regionalization methodology for forecasting regional environmental residuals.

CONCLUSION

This paper has argued for a new regionalization component for SEAS for the purpose of developing more accurate and defensible regional environmental forecasts which may better serve the analytical needs of EPA and DOE. A two-stage process has been suggested for improving the REGION module. The first stage, a short-term effort, intends to improve the regional data base in SEAS but to leave the current methodology intact. The second, which is longer-term, suggests a total restructuring of the regionalizing framework through the incorporation of a policy-sensitive multiregional economic model. Although no particular model has been proposed, a set of issues has been discussed which must be addressed if the integration of the model into SEAS is to be successfully accomplished.

What appears necessary and desirable at this point is a review of multiregional models in the context of SEAS and both EPA and DOE forecasting needs. By recognizing the limitations of the current regionalizing module, the needs of the agencies, and problems likely to be encountered in module design and development, a rational decision regarding the appropriate analytical framework for estimating regional pollution output should be possible.

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Approaches for Improving the SEAS Region Model: A Discussion Paper

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INTRODUCTION

This paper addresses the following objectives:

- Highlight the major drawbacks of the current structure of the SEAS REGION module
- Identify the attributes required in this module so that it can provide, at the same regional level, reliable estimates of Economic-Environmental-Energy interactions that could support model applications such as the Integrated Technology Assessment Program, Industrial Boilers Study, etc.
- Outline alternative strategies for bridging the gaps between the desired and available capabilities of the REGION Model System in the short run, intermediate run and in the long run.

THE CURRENT STATUS OF SEAS

The REGION Model

The purpose of REGION is to allocate national economic output, abatement costs and pollutant emissions developed by other SEAS modules (INFORUM, ABATE, RESGEN) to various regional units. REGION does not incorporate an analytical description of the structure of production and consumption in the regions or the economic interactions among regions in the country. Instead, it provides for a straightforward proportional allocation of a base year national sector output to regions based on the latter's proportional share of national employment in that sector.

$$X_{ijt} = X_{it} \frac{L_{ijt}}{L_{it}} \qquad (1)$$

where X and L represent output and employment in industrial sector i, j is the regional unit and t is the time period.

The use of the more readily available regional data on employment in Equation (1) implies an assumption of equal output per worker in a sector in all regions. (In some sectors, as in electric utilities, plant capacity data are substituted for employment in Equation (1).)

For a base year, the REGION model develops 18 sets of regional fractions termed SHARE ($=L_{ijt}/Lit$ in Equation (1)) to be applied to the national estimates to determine regional output and pollutant emissions. Nine of these SHAREs are intended to regionalize the output and abatement costs to any of the following regional levels:

1.	EPA Federal Regions	(10)
2.	States	(51)
3.	Standard Metropolitan Statistical Areas (SMSA)	(254)
4.	Air Quality Control Regions (AQCR)	(247)
5.	Major River Basins	(19)
6.	Minor River Basins	(221)
7.	Aggregated Subareas (ASA)	(101)
8.	Bureau of Economic Analysis Regions (BEA)	(173)
9.	Non-SMSA BEA Regions	

For each of the above, E-SHARE is computed as follows:

$\text{E-SHARE}_{ij(t)}$ = the proportion of output and abatement activity associated with sector i in regional unit j in year t.

The other nine SHAREs are for regionalizing pollutant emissions to any of the above nine regional units and are computed as follows:

$\text{P-SHARE}_{ij(t)}$ = the proportion of pollutant emissions derived from sector i in region j in year t.

The definition of P-SHARE in this manner implies that the national shares of all pollutant types associated with a sector and in any one region are the same. (This is modified in selected sectors, however.)

The E-SHARE and P-SHARE files are developed for a base year (1971) using employment data (as indicated earlier, for a few sectors plant capacity data are used) at the county level and aggregated to the desired regional level. Thus

$$\text{SHARE}_{ij}(1971) = \sum_{c=1}^{m} L_{ic}(1971) \Big/ \sum_{c=1}^{n} L_{ic}(1971) \qquad (2)$$

where c refers to a county and there are m counties that make up a regional unit j, and n counties make up the nation.

Economic Information System (EIS) is the source of REGION's base year data on $L_{ic(t)}$. EIS is a private company deriving its data for 115,000 industrial establishments by name and address, state and county, and by 4 digit SIC. Since these data are drawn from public sources, there are no disclosure problems. The data base, also known as the "Gould Tape" (after the President of EIS), is considered a reasonably complete survey of all plants in the continental U.S. with more than 20 employees. EIS claims completeness of data for plants with more than 250 employees, 98% accuracy in the range of 50-250 employees and 85% to 98% for plants with 20-50 employees. It does not cover plants with less than 20 employees.

The SHARE values are obtained for future years by utilizing the 1972 Office of Business Economics (OBERS), Projections of Economic Activity in the U.S. These projections of earnings put out by the U.S. Department of Commerce at the 2 digit SIC are used to compute an OBERS growth factor ($OG_{i,j}$). The latter is defined as follows:

$$OG_{i,j}(t) = OBERS_{i,j}(t) / OBERS_{i,j}(1971) \tag{3}$$

where $OG_{i,j}$ is the OBERS growth factor associated with the 2 digit SIC sector i' in regional unit j. $OBERS_{i,j}$ is defined as the industry earnings associated with i' in region j.

For each INFORUM sector included in the OBERS sector i', the projection year (t) SHARE values are computed:

$$SHARE_{ij}(t) = SHARE_{ij}(1971) \times OG_{i,j(t)} \tag{4}$$

The SHARE values in Equation (4) are normalized over all regions in sector i to sum to 1. Thus, the growth patterns in each of the 3 or 4 digit INFORUM sectors are constrained to that of the 2 digit OBERS sector they are contained in. OBERS makes projections for 37 economic sectors compared to INFORUM's 190.

A Critique of SEAS REGION

Given the quality of our present regional data bases, national models attempting to develop subnational economic information are confronted by a stark trade-off between data quality and small region detail. The designers of SEAS have placed a high premium on small region detail (county level) so as to gain the flexibility to represent information for a number of policy-relevant geographical units -- states, air quality control regions, river basins, etc. The resulting threat to the reliability of economic data (e.g., output by sector) has been countered by a very elaborate effort to recognize a large number (over 360) subsectors and processes [in INSIDE and ABATE Modules] at the national level. When information is available, the specific geographic locations of these subsectors and processes are identified, thereby augmenting the quality of some parts of the data base. While regional information is enriched for some sectors through elaborate subsectoring and process-descriptions, for the major part of the economy, the allocation procedures of Equation (4) hold.

The allocation procedures used in REGION have a number of drawbacks. The use of employment as a surrogate for output in REGION is acknowledged as introducing errors whenever output per worker levels vary significantly among regions, but was judged in the design phase of SEAS as not producing unreasonably great inaccuracies. Output per worker within a sector does vary considerably in response to a number of factors, such as process or product mix. In an industry with high capital investment and relative "stability" in the markets for the product, older plants are likely to continue producing in the face of competition from newer plants using different processes and capital/labor ratios. While each plant produces essentially the same type of product, their production processes differ. If that sector has experienced regional location shifts (such as textile plants moving from the Northeast to the South), differences in plant age and processes may be highly correlated with specific regions. Another problem is that the type of products classified under a single INFORUM sector (and indeed under any classification scheme with a reasonably limited number of sectors) may differ widely. "Apparel" produced in New York may involve expensive fashionable clothing. Apparel in Texas may be relatively labor intensive, taking advantage of the availability of less expensive labor. The point made here is that output per worker is sufficiently varied for a number of sectors, that the number of employees is a poor indicator of levels of output.

Second, the OBERS method of projecting regional growth to be built around a "shift share" model which extrapolates past locational patterns.

$$LS_{ij} = E_{ijt} - E_{ijo}\left(E_{it} / E_{io}\right) \tag{5}$$

where LS_{ij} = locational shift of industry i in region j between time periods t and o.

E_{ijt} and E_{ijo} are levels of economic activity in sector i, region j at time periods t and o.

E_{it} and E_{io} are national levels of economic activity in sector i at time periods t and o.

OBERS trends LS_{ij} into the future with the result that future locational shifts mirror only past ones and do not take into account the effects of dynamic factors on changes in regional comparative advantage.

Third, regional pollution emissions are obtained in SEAS on the assumption that a region has the same share of national emissions as it has of the national output. This assumption ignores differences in process mix, industry mix and environmental standards, plant age, etc., among regions, but still serves as a useful first approximation.

The fourth problem with the REGION estimates derives from the quality of its base year regional economic data base. Output by economic sector for the base year is estimated in the SEAS procedure by the use of Gould Tape. An earlier study suggested that serious measurement errors resulted from the procedure [Lakshmanan, Kroll, Chatterjee, Barron and Pappas (1977)].

SEAS-generated estimates of industrial output at the state level for 1972 were compared in that study with Census Bureau data for that year, presented in the Census of Manufactures (CM). Comparisons of these two data sets were made for 34 selected industries in a sample of 15 large states, after "purifying" the CM sectors, in the fashion of INFORUM sectors.

Once the necessary adjustments were made, the state CM and estimated SEAS values were compared, with substantial variation observed.

Measures of these variations are provided in Table 1. From these results, it is clear that SEAS' allocation of national output to regions involves substantial inaccuracy.

Since the SEAS REGION model allocates national output to region using employment shares, the ratio of state to national output per worker by industry (obtained from the Census of Manufactures) was used as an adjustment factor applied to SEAS state estimates. This adjustment step generally caused the SEAS REGION estimates to move closer to census data, but frequently the full difference was not accounted for. If it could be incorporated as a second factor in REGION's shares, however, substantial improvement may be obtained, at least for those sectors for which regional data are available. This suggestion was made under the presumption that regional output per worker differentials do not vary greatly in the four or five year intercensal period.

In summary, it appears that SEAS REGION model suffers from two classes of drawbacks -- analytical and data base related. The analytical deficiencies stem from the opaque structure of REGION and the limited or negligible 'policy handles' in the system. The assumptions built into the model are not made explicit and the regional estimates are sensitive to few, if any, economic or environmental or energy policies. However, the state-of-the-art of regional development theory and policy modelling provides ground for optimism that these analytical deficiencies can be addressed.

TABLE 1. SEAS/CM FRACTIONS FOR SELECTED STATES[a]

SEC-TOR	NY	OHIO	ILL	CAL	TEX	SEC-TOR	NY	OHIO	ILL	CAL	TEX
23	2.03	1.77	1.34	.98	1.26	76	1.00	D	.77	.73	.66[b]
24	.57	1.12	.60	.74	2.49	81	D	1.16	1.23	.85	.98
25	.74	.68	.98	.86	1.23	84	.83	1.67	1.10	D	D
26	.97	.90	1.23	.78	1.38	89	.45	1.27	D	D	D
27	.94	.93	.87	.92	1.45	94	.96	.99	1.20	D	D
31	.74	1.18	1.13	.66	D	95	1.20	.89	1.19	.95	1.14
39	.43	D	1.31	D	D	97	D	.88	1.08	1.51	3.02[b]
40	1.13	.61	1.03	1.20	1.51	98	1.04	.84	1.00	.90	2.41[b]
45	1.42	.79	1.33	.80	1.02	101	D	D	.83	D	D
51	1.17	.98	1.15	.75	.85	103	1.09[b]	1.02	1.16	D	1.77[b]
52	.98	1.07	1.11	.90	1.08	107	1.08	.70	1.03	D	.72[b]
53	.62	1.72	1.09	.61	D	113	.90	D	1.35	D	1.12[b]
54	.79	1.06	.99	1.16	2.11[b]	118	1.03	1.17	.96	D	.69
59	1.21	D	D	D	.61	119	1.56	.95	1.31	1.00	.90
66	.62	1.06	1.32	1.28	1.50[b]	123	D	1.38	1.03	.75	.55
67	1.71	1.29	.77	1.39	1.18	127	1.06	1.13	.98	.99	D
69	D	.61	1.41	.93	1.12	128	.50	.93	1.29	1.16	D

[a] SEAS is modified by the price and scaling factor; CM is modified by the purification correction factor. No modification has been made for O/W differences.

[b] State accounts for less than 1% of total sector output.

D = Disclosure limitation

Source: T.R. Lakshmanan, et. al. 1977.

Improvement of the analytical structure of SEAS REGION is just a matter of focusing enough skilled manpower and money. Some strategic choices in such a focus are discussed in the next section.

Improvements in the data base (while dependent on the analytical structure) are largely a matter of directing enough resources -- time and money.

DESIRED ATTRIBUTES OF SEAS REGION MODEL

The informational requirements of a policy application such as the Integrated Technology Assessment (ITA, e.g., Western Coal, Ohio River Basin, etc.) are reliable regional descriptions of a broad range of economic-environmental-energy interactions. Further, such estimates of interactions must be available for alternative economic, environmental and energy policy interventions.

For instance, the Ohio River Basin Energy Study (ORBES) attempts to assess the potential economic, social and environmental impacts of proposed concentration of power plants in the lower Ohio River Basin. The policy issues emerging from this assessment pertain to:

- The appropriate balance in the use of land between energy (industrial) development on the one hand, and agricultural, open space or other uses on the other.
- Management of growth, growing demand for public service, public finance and urban planning at the regional and local levels.
- Environmental impacts at the subnational level (e.g., Interstate flow of air pollutants).
- The chemical transport of air pollutants, with undesirable effects of unregulated secondary pollutants on human health and environmental quality.

The regional information required to address these issues fall into two classes:

- economic impacts -- output, income, employment, investment, consumption, taxes, labor force, prices, energy demand and supply, etc. -- and environmental residuals by type and medium of discharge.
- ecological and health impacts of environmental residuals resulting from physical, chemical or biological processes operative at a local level. In addition, the relation of those impacts to the "carrying capacity" of the region is of interest.

Our focus in this paper is limited strictly to the first class of impacts listed above. If the technical relationships between economic sector output and type and generation rate of pollutants is viewed or given, the impacts of interest turn out to be limited regional economic variables.

A regional model that is capable of providing such comprehensive conditional economic estimates related to alternative policy instruments (e.g., pertaining to economic change, environmental pollution abatement incentives and standards, energy supply, etc.) must have a number of attributes.

- Transparent Structure

  The Model must describe the processes of regional change and development in an explicit manner. Economic and spatial theory appropriate for this purpose must be embedded in the model. Implicit relationships and "black box" characteristics (as for example in the OBERS model) must be minimized in the specification.

- Comprehensive

  The endogenous variables must be as numerous as possible and exogenously specified variables kept to a minimum to increase the usefulness of the model.

- Interregional

  The multiregional model must be specified to be interregional as well; i.e., the level and mix of economic activities in a particular region must be responsive to related factors in other regions.

- Policy Sufficiency

  Adequate 'policy handles' (the variables that are directly affected by government policies) must be specified into the model. Often in otherwise complex models, key policy handles such as capital stock, investment, taxes, prices (input or output) may be missing.

- Consistency

  Regional stock and flow variables must add up to national levels and to interregional balance.

To achieve these attributes, the SEAS REGION model must incorporate the following types of theoretical notions about the functioning of economies in space:

a) Interregional Comparative Advantage: The location of economic activities whose outputs are determined in national markets is a matter of regional comparative advantage. Such comparative advantage is determined by relative input prices and interregional market access.

Interregional linkages to markets must be built into the model by specification of the size and the spatial array of relevant markets. Inputs whose relative prices are important should include not only labor and transport -- traditionally considered in regional location models -- but also the costs of pollution abatement and energy supply. As environmental standards pertaining to industries, automobiles and municipalities are implemented, different sectors are affected differently in terms of production costs and market demand. While the combination of goods and services produced in the nation changes as a consequence, these changes are reflected in the regional economies depending upon their industrial mix, incomes and consumption patterns. Similarly, the effects of higher costs of energy vary among industries depending upon their degree of embodied energy and also incident on consumer cost of living.

Thus, competitive prices of input will affect the demand for labor -- for different sectors. In addition, the notion of relative living costs should be introduced in the supply side -- demographic and labor supply equations -- as well.

b) Comprehensive Intersectoral Demand: The model must describe the direct, indirect and induced economic impacts. This capability is most easily provided in an I-O model which is a pure demand allocation model.

c) Long Run Supply Effects: Most models focus on the demand side and ignore the inelasticities of supply in regions. Attention has been drawn to the need for modelling for supply factors in labor supply. Far more important is the role of Capital Stock in affecting supply responses.

d) Investment Effects: Much of the policy analysis in energy and environmental areas focuses on altering the regional allocation of investment. The model should be able to capture the effects of public policy incentives for augmenting investment.

e) Regional Income and Public Finance Effects: The model should treat the effects of economic growth on regional income, consumption, government expenditure and taxes at the regional level, so as to provide the information for regional public finance and urban planning.

f) Integration of National to Regional (top down) and Regional to National (bottom up) Information Flows: Certain variables are entirely determined at the national level (e.g., exports, imports, interest rates, some prices, etc.). Others (e.g., labor force, industry output, some types of investment and price, employment and components of income) need to be aggregated from the regions up to the nation. The model should be, thus, a mixture or "hybrid" of top down and bottom up approaches.

g) Lagged Adjustments to Changes: Households and firms adjust their locations over time in response to changing regional comparative advantage. The structure of this lagged adjustment process must be captured so as to replicate reliably regional change.

In summary, it is suggested here that if SEAS REGION Model is to be responsive to ITAs, it must be an interregional comprehensive model that would have a transparent structure and adequate policy handles. To develop such a model, explicit specifications of theoretical notions pertaining to interregional comparative advantage, comprehensive intersectoral demand, long run supply effects, regional income and consumption determination, public finance, and bidirectional information flows (between national and regional levels) must be built in.

What are the prospects for developing such a model? We address this issue in the next section.

A TIME PHASED STRATEGY TO IMPROVING SEAS REGION

The attributes listed in the last section as desired in the SEAS REGION model, while relevant to a policy application such as an ITA, are not attained in any one existing multiregional model. This situation is definately a comment on the state of regional modelling.

However, a number of multiregional models are available that provide some mix of these desired structural characteristics (Ballard and Wendling, 1978; Bray, Gonzalez and Nakosteen, 1979; Fromm and McCarthy, 1978; Harris, 1973; Hopkins, 1978; Lakshmanan and Lo, 1972; Lakshmanan 1977, 1979; Olsen et al., 1977; Polenske, 1972; Treyz, 1979). Many of these models reflect an electric design strategy, drawing in varying degrees on various theoretical -- location theory, input-output, neoclassical general equilibrium and econometric modelling -strands. Each model is useful for some purposes but not for others. Some models emphasize demand components; others make a beginning on a balanced demand supply relations. Some treat capital stock and investment explicitly; others elaborate local income expenditure relationships. Yet, others operationalize explicit notions of interregional comparative advantage. Some models are at the state level, while others try federal regions, BEA areas and counties.

What appears to emerge from a quick survey of the state of these diverse modelling projects is the following view: while much valuable knowledge relevant to SEAS REGION model will result from these efforts, the time frame for translating such knowledge into a framework for developing an improved SEAS REGION (as described in the last section) must be "long term," here defined as 18 months and over.

This suggests in our view a time-phased strategy for improving the SEAS REGION model. We recognize, somewhat arbitrarily, three time frames:

- 'Long run' (18 months +)
- 'Intermediate run' (6-18 months)
- 'Short run' (less than 6 months)

The long run strategy for improving SEAS REGION was addressed by some of the leading principals and critics of regional models in a recent U.S. Department of Energy Workshop on "National Regional Models: Integrating Top Down and Bottom Up Approaches" at Reston, Virginia. The results are to appear in a report by Lawrence Berkeley Laboratory and will not be labored here. The major recommendation was for a multi-level modelling system built modularly around a unified national-regional accounting framework. Steps needed to implement such an approach are detailed in that report.

While we recognize a short term frame, we do not see much point in presenting specific programs of improving SEAS REGION. The time frame, the resources, and the degrees of freedom are too restricted for this.

However, there are viable options for improving SEAS REGION system in the intermediate run (6-18 months). These options all involve retaining the current structure, but improving the quality of regional estimates. They fall into three classes:

(a) Improving the base year data

(b) Augmenting the sectoral and process detail at the regional level

(c) Increasing the level of explicitness of relationships in SEAS REGION, so as to increase policy applications.

a. Base Year Data Base:

As mentioned earlier, there are opportunities for standardizing and improving the base year data on regional output. These and other elements of the base year data base at the national and regional level need to be explored. This would be a high payoff effort if structured appropriately in the workshop.

b. Sectoral Detail:

SEAS has exploited in the past the access to national data bases and modelling systems in energy and environment by augmenting greatly sectoral and process detail. This process could be continued to incorporate information on specific sectors (e.g., energy technologies, specific sectors such as construction, paper and pulp, etc.). If such opportunities exist, the relevant information can be incorporated into SEAS REGION through override provisions. Such opportunities need to be explored.

c. Increasing the Level of Explicitness:

A number of relationships between endogenous variables and "policy handles" are implicit in SEAS REGION. Selectively, some of these could be made more explicit. One way to do this would be to incorporate specific 'blocks' of available regional models. Examples of such 'blocks' that could be integrated into SEAS REGION (with some ingenuity) are:

(i) An income, consumption and regional public expenditure block from an existing model. (Such a model would help in developing local growth and public finance effects of energy facilities.)

(ii) A labor force supply block

(iii) Other

A well structured dialogue between SEAS REGION modellers and selected outside regional economists could help in this process.

Comments for the SEAS Regionalization Workshop

Robert A. Nakosteen

Tennessee Valley Authority

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INTRODUCTION

The Strategic Environmental Assessment System (SEAS) is a large, computer-based model used by both the Environmental Protection Agency (EPA) and the Department of Energy (DOE) to assess the impact of governmental policies on the economy and the environment. The planners of the model well understood that no single model can answer every question. Any model attempting to do this would be so bulky so as to render it useless. On the other hand, the original modelers wanted to develop an instrument capable of handling a wide variety of questions. A compromise was reached in the decision to construct the model as a system of interrelated models, or modules, each of which could be independently run. Each module would then be focused on a particular problem area, e.g., the national economy or residuals generation. With the modular approach, the modules used depend on the question being asked. Only relevant modules need be exercised, thus diminishing the awkwardness of a bulky model.

The focus of the Regional Economic Modeling Workshop is on one of these modules, the regionalization module. The emphasis of the SEAS model has been on national activity. Obviously, in dealing with environmental issues, the Nation as a whole is usually not the area of interest. Although national levels of residuals may remain unchanged over different scenarios, the regional distribution may be quite different, with different problem areas associated with each. Thus, this is an important module in the SEAS framework.

Unfortunately, the presently operational regionalization module is inadequate for the tasks required of it. The regionalization module assigns regional shares of national activity primarily based on trends and the OBERS projections. When the questions being asked involve major structural changes diverging from past trends, allocations based on these cannot possibly be accurate.

The modular approach is powerful in that it allows for an integrated system and, at the same time, allows a great deal of flexibility in the type of questions that can be addressed. However, for such an approach to work, it must indeed be an integrated framework. This means that all the modules must be based on a consistent set of assumptions. For the regionalization module to properly allocate national activity, it must be responsive to the assumptions, either explicit or implicit, incorporated in the other modules. This may be done either directly by using a structural model of regions or through side calculations, or more likely through a combination of both. This would appear to be of primary importance in any attempt to improve the regionalization of SEAS output.

With this point in mind, there are several questions which arise:

1) What is the best measure of activity for regional allocation?

2) What are possible data sources?

3) To what spatial area should the activity be regionalized? These are all fruitful questions that can be pursued in the workshop. As to the first one, it would not appear to be a useful exercise to regionalize each SEAS component independently. Again, this may lead to internal inconsistencies. Rather, a more fruitful approach is to allocate measures of economic activity to a regional level. Once this central measure is scaled down to a region, economic activity in the region can be used to assign other SEAS output, such as residuals, to a regional level. This still leaves a question as to which measure of economic activity, i.e., output, employment, etc., would be best to use. This leads into the second question listed above, that of data availability.

Data availability is not just a question of where to get certain data, but also how to create data from that which is available. Techniques by which data can be created for the purposes at hand is also an important topic of discussion.

The third question listed above relates to the spatial area of analysis. The area of analysis is determined by the policy question involved. However, to have a flexible regionalization module, disaggregation to the county level is a necessity. With county output, aggregation to any multicounty area of interest becomes a simple matter. The need for county output, however, does not mean that the principal regionalization module need assign activity to that level. Simple trend allocations have already been rejected. Thus, the regionalization module must incorporate a structure which embodies regional characteristics. An appropriate area of analysis for this is Bureau of Economic Analysis (BEA) economic area. This is an economically cohesive multicounty unit. The regionalization module can then further disaggregate to counties through a simpler technique, since the counties in such an area are likely to share many of the same characteristics.

All of the above questions are interdependent with the actual structure of the regional module. Thus far, the only qualification given is that the module must be responsive to changes in assumptions in other SEAS modules and, thus, cannot be based simply on trends. Ideally, a model would be build for each BEA area which would capture each region's characteristics and be responsive to changing scenarios. This is, however, a costly and time-consuming process. For certain EPA policy questions, the degree of accuracy and detail gained from the construction of such a model for a particular region could easily be worthwhile. Over time, a collection of such models could be built and maintained as such policy questions arose. This is, however, a long-run solution. In the shorter run, the regionalization module should be developed which is not as rich in regional detail, but is still capable of being responsive to such policy questions as the effect of changing energy prices, since differential regional effects are to be expected. Also, the module should be able to accomplish this allocation to at least the level of small regional units, such as BEA areas, for the Nation.

One final point is that a procedure should be developed by which the regionalization module should be verified. Obviously, the module can be run over an historical period for which data are available. This, however, will not really allow for the testing of its simulation capabilities. A fruitful approach here would be to compare its output to that from a model which has been constructed for a specific area. Running both the regionalization module and the regional model for the same scenarios can point out strengths and weaknesses in the regionalization module. This analysis would be of invaluable aid in the development of such a module.

TVA'S REGIONAL ECONOMIC SIMULATION MODEL (RESM)

Economists at TVA have developed research representing an advancement in modeling methodology which provides the user with a multidimensional planning instrument in the examination of regional activity and policy impacts. A regional econometric simulation model (RESM) was developed for the TVA power service area* (PSA) in the spirit of the Battelle model of the Susquehanna River Valley of Hamilton et al. (1969), mapping the regional economy with the proper linkages and feedbacks between the demographic, employment, income, financial, and product sectors, so as to realistically simulate policy actions. At the same time, the model provides reasonable forecast of activity, a rarity among regional models.

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*The power service area is a 170-county region incorporating the State of Tennessee and parts of six other states.

The model, RESM, allocates national economic activity to the region through its link with a national econometric model, but not in a simplistic fashion. National variables enter the model specification to incorporate trends and markets that are national in scope. However, regional characteristics and resource constraints are also incorporated in the analysis. Until very recently, resource constraints were glossed over in regional models. Even today, only a few models incorporate such measures. The present model is unique in the variety and number of resource variables interlaced into its specification. The regional supply of capital is evident in the loan-to-deposit ratio endogenously determined. Input costs enter the analysis in the form of relative (to the U.S.) earnings rates and power costs in the manufacturing analysis. The ratio of employment to population is endogenously determined by regional forces representing the potential labor supply and labor market pressures.

The model not only provides reasonable forecasts, but is also a useful policy simulation tool, since relevant supply factors are incorporated in the manufacturing analysis. At least one of these factors appears in each of 19 of the 21 manufacturing equations.

In the development of the manufacturing employment sector, the researchers were faced with the same sparsity of data (16 annual observations were available) as other modelers. It was, therefore, not possible to directly incorporate the supply factors into the estimated time-series equations. Rather, supply factor elasticities were derived from a manufacturing analysis using pooled time-series cross-section data for 47 Bureau of Economic Analysis (BEA) economic areas in the South for the period 1969-1973. It was felt that the larger data set (235 observations) allowed sufficient variation in the sample so that estimated elasticities would be more accurate estimates of their true parameter values. A time-series analysis was then performed on each of the two-digit manufacturing industries, while restricting the supply factor parameters to those elasticities derived from the BEA area analysis.

This technique mitigates one of the major objections to use of extraneous information in model estimation, as depicted in the classic article by Kuh and Meyer (1957). Kuh and Meyer argued that, when time-series data are inadequate, analysts resort to use of cross-section data. The elasticities estimated with cross-section data tend to be of a longer run nature for an economy in equilibrium than the equivalent time-series elasticities. Thus, it would be incorrect to impose these without adjustment.

As mentioned, the elasticities estimated here, however, were derived from a pooled time-series of cross-sections in a dynamic framework. Thus, they represent shorter run trends closer in nature to the other elasticities estimate with the time-series data than those derived from strictly cross-sectional studies.

For example, the relative earnings per employee in manufacturing variable appears in 11 of the 21 manufacturing equations. The relative power cost variable has a non-zero coefficient in 16 of the 21 equations. The elasticities for the relative earnings rate vary from a low of -.04 in the food (SIC 20) industry to a high of -.8 in textiles (SIC 22). The elasticity is greater (in absolute value) than -.3 in nine equations. The elasticities for relative power cost vary from -.01 in printing and publishing (SIC 27) to -.53 in non-ferrous smelting (SIC 33) and electrical machinery (SIC 36). The elasticity is greater (in absolute value) than or equal to -.2 in 11 equations. Thus, it is evident that regional supply constraints are a significant factor in this model.

The degree of industry detail (at the two-digit SIC industry level for employment and earnings, and a high degree of disaggregation in other sectors as well) is also unique in regional econometric models. This is important not only due to the detail in which policy impacts can be traced, but also due to the better model specification possible with this level of detail. For example, the U.S. input-output table was used to identify industry linkages. These were then incorporated into the model specification. Thus, the chemicals industry sells to the textiles industry and, therefore, employment in chemicals is tied to production in textiles in the model specification.

In addition, this model is the first to use ridge regression in the estimation of the equations of a regional model. Ridge regression is a purely statistical technique which has recently been shown to be extremely effective in dealing with statistical problems of economic time-series data.

THE RIDGE REGRESSION ESTIMATOR

Linear regression analysis is a statistical technique widely used by regional modelers but, as discussed in Johnston (1976), for example, the desirable properties of the technique break down under a variety of conditions. Multicollinearity in the regressors can cause the estimated coefficients to be too large in absolute value, often causing certain coefficients to enter the equation with the "wrong" signs. Large standard errors of the regression coefficients are also estimated in the presence of multicollinearity, thus resulting in the inability to reject diverse hypotheses concerning them. Autocorrelation in the residuals of the regression equation, another econometric problem that is commonly found in time-series equations, affects the efficiency of the regression coefficients.

Econometricians have historically been faced with the above problems when estimating equations with data similar to that used in RESM. Given the state of the art, the empirical researcher is generally left with no recourse but to address what is felt to be the predominant problem and ignore the minor ones. Common approaches have been to ignore all problems and use the ordinary least squares (OLS) estimator, address the autocorrelation problem with a generalized estimation (GLS), or drop collinear "nuisance" variables in conjunction with one of the above alternatives.* Little research, however, has been devoted to a methodology that would allow the researcher to handle multiple econometric problems simultaneously.

Recently, Monte Carlo studies have been designed to determine the estimator that best handles the problems characteristic of time-series data. A major conclusion of the studies is that a biased estimator, the ridge regression estimator, consistently outperforms OLS and other unbiased estimators. Based on the results of the Monte Carlo studies, both at TVA and elsewhere, and the results of other studies that have used ridge regressions, this technique is used in the estimation of most equations in RESM.**

A VALIDATION PROPOSAL

The methodology developed in RESM is in the process of being applied individually to a series of Southeastern BEA economic areas. When operational, output from these models could be used to validate output from the SEAS regionalization module for selected labor market areas. A county allocation procedure will be developed, allowing projections to be scaled down to more detailed geographic units and, subsequently, cumulated to any used unit composed of county building blocks. Utilizing the restricted least squares technique, supply constraints relevant to EPA/DOE analysis can be built into each labor market model. Employment or output data, produced by the models, could be linked to a residuals matrix, providing information on environmental impacts of various activities.

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*In the conditional omitted variable (COV) estimator, the procedure is to estimate an equation with OLS and then examine the "t" ratios for the advisability of dropping certain variables. If the coefficient of a "nuisance" variable has a low "t" statistic, the equation is reestimated without this variable. Otherwise, the original OLS estimate is retained. For a discussion of the COV estimator, see Felstein (1973).

**For example, see White and White (1976). Monte Carlo studies include the two papers of Swamy and Rappoport (1975 and 1978) and Murphree (1978).

With the inclusion of such information in a model methodology which has been constructed with such linkages in mind, detailed validation of SEAS regionalization modules can be attained. The methodology developed at TVA allows low cost model reformulation, incorporating new supply constraints or linking to additional secondary data tables as the need and interest arises.

To summarize, an important aspect of improving the SEAS regionalization module is the validation of such a procedure. At TVA, we are developing a series of detailed models for selected Southeastern BEA areas. The models take advantage of various methodological advances which make them quite flexible, amenable to the validation of the SEAS regionalization procedure for a large number of potential applications.

Memoranda to Paul Schwengels Regarding SEAS Regionalization

Barry Sedlik
TEKNEKRON
1483 Chain Bridge Road
McLean, Virginia 2201

MEMORANDUM

TO: Paul Schwengels DATE: July 11, 1979

FROM: Barry Sedlik

SUBJECT: Regionalization Aspects of the Industrial Boiler Model

One of the prime measures of the success of the Industrial Boiler Model project will be the degree to which regional aspects are credibly addressed. The key problem is to achieve an appropriate balance between the need for "fine" locational detail and the model's ability to specify such detail in a rigorous and defensible fashion. On the "needs" end of the spectrum are (1) the voracious appetite of air quality models for emission source location specificity; and (2) the need to evaluate combustion and pollution control options on a region-specific basis. On the "ability" side are (1) limits imposed by data availability; (2) uncertainty in industrial capacity requirements; and (3) the problem of capturing the "flavor" of management decision-making in the siting of new facilities.

Discussion of these items is presented below.

THE NEED FOR REGIONAL DETAIL

Regional specificity is motivated by two major requirements: (1) the need to localize emission sources for air quality analyses; and (2) the need to discriminate among combustion/pollution control strategies to meet prevailing emission limitations in the most economic manner.

The Air Quality Problem

Regarding the first requirement, the credibility of air quality analysis techniques in identifying areas in violation of ambient air quality standards is of utmost importance. From a policy viewpoint, the siting of future industrial facilities will, to some extent,* depend on the level of pollution control required for existing and new facilities, as well as the ambient air quality of proposed sites. Specifically, the influence of nonattainment and significant deterioration provisions of the Clean Air Act must be seriously addressed. Previous studies have assumed that new facilities would be excluded from nonattainment and Class I PSD areas. However, as many industrial plants are located in existing nonattainment areas (thus, the most likely expansion sites), these simplifications could bias policy analysis results to a large extent. Acceptable methods of accounting for emission offsets (for nonattainment areas) and air quality increments (for significant deterioration areas) must be established as integral parts of the modeling effort.

The identification of probable areas of air quality violation is more valid when the location of emission sources is known with some precision. In addition, results from OBERS indicate that the relative location of sources is also crucial due to atmospheric processes of source intensification and pollutant transport/transformation. In the ideal case, sources would be identified by their precise geographic coordinates. Even so, the ability of air quality models to "track" air quality is limited. The accuracy deteriorates rapidly as the location of sources becomes more and more obscure. Thus, the first element of concern is establishing the largest region size in which air quality models would be sensitive to the placement of additional sources.

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*A key application of the model will be to determine the influence of environmental policy on industrial siting patterns.

Combustion/Pollution Control Strategies

Assuming the above problem is resolved, the second major challenge in providing regional detail is the ability to discriminate among alternate methods of combustion strategies that meet prevailing emission limitations. Since coal is a heterogeneous material, significant variation in combustion cost can result from employing different strategies to meet the same emission limit. In this sense, a strategy is defined by the combination of coal type, boiler type, and pollution control method that can meet a designated firing rate (millions of Btu's per hour) and specified emission limits for criteria pollutants (SO_2, NO_x, TSP) within the framework of allowable technology (e.g., Best Available Control Technology, Reasonably Available Control Technology, Lowest Achievable Emission Rate, etc.). Such strategies are highly regional dependent in that variation in coal heating value (Btu's per pound), sulfur content (% sulfur), F.O.B. mine price (dollars per ton), and transportation costs to the point of combustion (dollars per ton) will result in a wide range of delivered coal cost on a cents per million Btu basis, depending on the point of origin. When it is also considered that boiler choice is a function of coal type and that the degree of pollution control (e.g., coal cleaning, flue gas scrubbing) also depends on coal properties, an even wider variation in cost expressed on an "as-burned" basis results. All else being equal (e.g., no mandated use of particular coal), operators would employ the strategy that can meet all demand and pollution control objectives on a lowest overall as-burn basis. Regionalization is of crucial concern in this process, since transportation can be a major element of the as-burned cost. In previous studies, it has been found that transportation can account for more than 50 percent of the overall as-burned cost. Thus, the higher the degree of location specificity in origin/destination pairs, the greater the ability to discriminate among economic combustion strategies.

LIMITATIONS ON REGIONAL DETAIL

Limitations on providing the desired degree of regional detail stem from three major areas: (1) availability of data; (2) uncertainty of industry's requirements for new capacity; and (3) the complexity of the siting problem. Each of these areas is addressed below.

Data Availability

Estimates from various sources place the population of industrial boilers at approximately 22,000 units. Of this number, the location and description are known for about 6,000 (the large units that were identified by the 1974 Major Fuel Burning Installation Survey). Thus, with the location of only about a quarter of the population of the existing units known with any precision, it is difficult to project where new units will be sited. Ongoing work by EPA and others in conducting new surveys may ameliorate this problem somewhat.

New Capacity Requirements

Upon inspection, the dimension of the industrial capacity expansion problem is seen to be more complex than previous modeling approaches have acknowledged. First, previous analyses of industrial boilers all assume that combustion energy requirements are linearly related to product output growth with (in some cases) adjustments for energy conservation. However, just as the electric utilities industry can "dispatch" existing capacity to meet increasing load before adding new capacity, industry as well can "dispatch" existing facilities to meet increasing product demand before new capacity and new boilers are required. It must be remembered that energy is just one (albeit an important) factor in the production process; thus, attempts to relate the need for new combustion facilities to product demand must be constructed carefully. Although in an ideal sense supply and demand consideration would result in least-cost expansion strategies for a particular industry, competition and lack of perfect information will result in cyclical swings of capacity excess and deficiency.

The Siting Problem

The siting problem is, perhaps, the most complex of the entire modeling effort. If it can be assumed that aggregate capacity expansion needs can be determined at the national level for each industry of concern, then the problem of siting new (and replacement) capacity must be addressed. Previous analyses have handled this problem in one of two ways. One way has been to assume that new capacity will follow historical location patterns. This method suffers from two key deficiencies. First, there is the data problem cited above. If 75 percent of the historical locations are unknown, then a large bias will be built into the future siting pattern. Second, even if a complete historical record were available, then this method by definition assumes that future patterns will mirror the historical ones -- a shaky assumption considering recent migratory trends and, more important, the impact of pollution control requirements.

The second major siting algorithm in use assumes that siting of new plants will follow projections of future regional economic activity. Typically, the OBERS projection of the Bureau of Economic Analysis is used for this purpose, in spite of this explicit warning in the foreword of the OBERS projection report:

> "The OBERS projections do not reflect the current energy problem, recent changes in agricultural exports and recent changes in conservation and environmental activities..."

Such use exemplifies the problem of using independent projections that also make independent (and not necessarily consistent) assumptions. It is obvious that more work must be done in this area so that credible siting algorithms can be developed.

MEMORANDUM

TO: Paul Schwengels DATE: September 27, 1979

FROM: Barry Sedlik

SUBJECT: Additional Aspects of Industrial Energy Use and Regionalization

The purpose of this memo is to provide additional background material to familiarize the participants in the regionalization workshop with the scope of the industrial boiler regionalization problem. Specifically, three items are discussed. First, some statistics on energy use in industry are provided. Second, the industries that are most reliant on boilers, along with the industries that would be most impacted by boiler-related energy and environmental legislation, are identified. Finally, a discussion on the regional issues and suggested methods of their resolution are explored.

BACKGROUND

According to the latest Energy Information Administration (EIA) data, of the 78 quads of domestic energy consumption in 1978, fully 28 quads (36 percent) can be attributed to energy use in the industrial sector. However, only 18 quads (24 percent) was obtained from direct, non-electric energy sources. Since the early 1950's, industry's share of total energy consumption has declined, representing an increased reliance on purchased electricity to fulfill energy needs. Of all industry, manufacturing is by far the heaviest energy user.

Agriculture, mining, and construction combined use only about 20 percent of industrial energy, with the balance going to the manufacturing sector.

Energy is used for a variety of purposes in manufacturing. The following is a distribution of end use as compiled in EIA's End Use Energy Consumption Data Base (ECDB) based on 1974 data:

Direct Heat	26.4%
Other	21.4%
Process Steam	21.0%
Raw Materials	19.3%
Machine Drive	5.0%
Electric Generation	2.5%
Electrolytic	1.9%
Coke Production	1.8%
Space Heating & Cooling	0.5%
Lighting	0.2%
	100.0%

Of all these uses, boilers are used to fulfill process steam, electric generation, and space heating and cooling requirements. In 1974, boilers were used to provide between 23 percent and 50 percent of all end use requirements in manufacturing, depending on the extent to which "other" uses were supplied by boiler-derived energy. This represents 7 percent to 15 percent of all U.S. energy consumption in 1974.

In addition to the level of consumption represented by manufacturing boiler use, the mix of fuels that supply boiler energy is of utmost concern. While reliable data regarding industrial boiler fuel use is unavailable, consumption by fuel type can be inferred from other sources. Utilizing ECDB data for the boiler applicable uses specified above produces the following estimates of fuel consumption in manufacturing for boiler firing in 1974:

Fuel	Boiler-Fired Consumption	%Industrial Consumption	% United States Consumption
Coal	33-46 million tons	52-72	6-8
Distillate Oil	75,000-180,000 barrels per day	12-18	2-3
Residual Oil	290,000-390,000 barrels per day		
Natural Gas	2.0-3.7 trillion cubic feet	24-45	9-17

While boiler firing represents the dominant use of coal in manufacturing, it constitutes a fairly small percentage of total coal use in the nation. Conversely, non-boiler uses of natural gas make up the majority of manufacturing natural gas use, yet manufacturing boilers may be burning up to 17 percent of the total U.S. natural gas consumption. Fuel oil use in manufacturing boilers is of lesser consequence, but remains a focal point of national energy policy.

AFFECTED INDUSTRIES

The latest Census of Manufacturers (1977) indicates that there are approximately 340,000 manufacturing establishments in the United States, of which 120,000 employ 20 or more employees. Energy consumption among all these plants is heavily dependent on the industry to which the plants belong. Figure 1 summarizes the distribution of total energy consumption by industry. Of note is the fact that the four largest industries consume over one-third of all energy consumption in manufacturing. Furthermore, the 16 largest manufacturing industries constitute almost 60 percent of energy consumption in the manufacturing sector. Efforts are now underway to identify which of these industries are intensive, actual, or potential boiler users. In a recent study conducted for EPA, three major manufacturing industries (pulp and paper, primary metals, and chemicals), along with mineral production, were shown to account for 82 percent of total energy used to produce process steam and operate the majority of the estimated 504,000 industrial boilers. A preliminary analysis of intensive steam users indicates the following major industry groups are likely candidates for further analysis:

CONSUMPTION OF PURCHASED FUELS AND ELECTRIC ENERGY,
BY THE SIXTEEN LARGEST ENERGY-CONSUMING INDUSTRIES: 1976

Rank	SIC code	Description	Btu consumption (Trillions)
1	3312	Blast furnaces and steel mills	1,427.4
2	2911	Petroleum refining	1,217.9
3	2869	Industrial organic chemicals, n.e.c	1,097.8
4	2621	Papermills, excluding building paper	587.5
(X)		Largest 4	4,330.6
5	2631	Paperboard mills	465.2
6	3241	Cement, hydraulic	434.4
7	2819	Industrial inorganic chemicals, n.e.c	421.0
8	2873	Nitrogenous fertilizers	299.7
(X)		Largest 8	5,950.9
9	3334	Primary aluminum	297.1
10	2865	Cyclic crudes and intermediates	170.8
11	2821	Plastics materials and resins	168.1
12	2812	Alkalies and chlorine	153.1
13	3221	Glass containers	147.2
14	2824	Organic fibers, noncellulosic	132.3
15	3714	Motor vehicle parts, accessories	130.0
16	3711	Motor vehicle and car bodies	119.2
(X)		Largest 16	7,268.7
(X)		All others	5,356.6
		Total	12,625.3

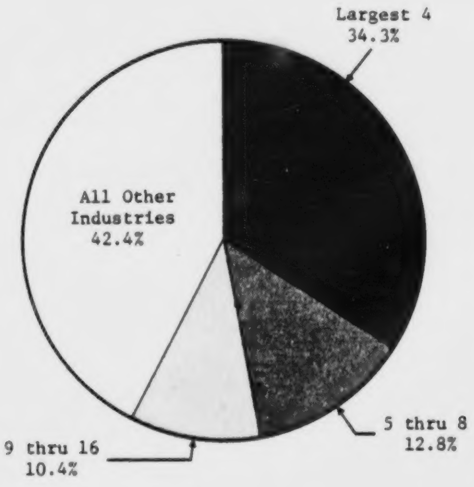

FIGURE 1
LARGEST 4, 8, AND 16 ENERGY CONSUMING INDUSTRIES AS A PERCENTAGE OF THE TOTAL ENERGY CONSUMPTION BY ALL MANUFACTURING INDUSTRIES: 1976

Source: U.S. Bureau of the Census, The Annual Survey of Manufacturers, 1976.

SIC Code	Description
20	Food and Kindred Products
22	Textile Mill Products
26	Paper and Allied Products
28	Chemical and Allied Products
29	Petroleum and Coal Products
33	Primary Metal Industries

REGIONALIZATION ISSUES

From a modeling perspective, two key factors must be dealt with at a regional level. The simpler of the two regards the existing industrial boiler population. In this regard, by assuming salient characteristics about boilers used in each affected industry (e.g., number, size, type, fuel, etc.), the distribution of the existing boiler population can be mapped with a high degree of precision. However, the future population (up to the year 2000) is much more difficult to ascertain in both magnitude and distribution. The reason, of course, is that information regarding industry's expansion plans must be identified on an industry-by-industry basis. The problem is further complicated by the degree to which each industry is affected by overall economic conditions and changes in consumption patterns. To the extent that these "macro" conditions influence the level of demand, economic projections of industry growth can be used to determine the amount of new capacity that must be built to meet demand over the time horizon of interest. Characterization of each industry regarding typical plant size, configuration and retirement rates must also be developed. Financial data must be compiled as well to determine if capital would be available to meet expansion requirements.

Once the level of new capacity requirements is ascertained, then the distribution of these new plants must be determined. As it would be quite different to estimate all the factors involved in industry siting behavior, two classes of locational preference would be established: supply centered and market centered. The supply centered industries generally require a complex infrastructure of raw materials, related plants and transportation networks to meet their supply requirements. These industries have low mobility and thus would tend to build new plants in the vicinity of existing ones. Most of these industries are manufacturers of producer goods.

On the other end of the spectrum are the market centered industries that tend to follow changing population patterns. These industries are mostly engaged in the production of consumer goods. It is interesting to note that, in a survey conducted for the Economic Development Administration in 1970, proximity to market was consistently ranked as a high priority in the locational objective in the siting of new capacity.

It is envisioned that a siting algorithm would be developed for each industry that would assign location based on these preference criteria. When more than one region (e.g., BEA zone or AQCR) would be equally preferable, the algorithm would default to locating facilities on a least-cost boiler and fuel supply basis.

Improving the SEAS Regional Capability

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INTRODUCTION

The use of the Strategic Environmental Assessment System (SEAS) as a general tool for the regional analysis of potential impacts of energy and environmental policies has generated considerable debate. Areas of concern have focused[1] on the quality of historical reference data, reasonableness and consistency of scenario projections, validity of the regionalization methodology, and the lack of systematic documentation of the components of the system.

In particular, the lack of clear, systematic documentation has generated two opposing viewpoints. The first is that with better documentation, and with more accurate and detailed historic data to initialize the model, the system will operate effectively. At the other extreme, some users and modelers have expressed the opinion, usually after trying to digest the documentation which does exist, that the whole system should be replaced by a "new" integrated economic and environmental system. Neither of these views is likely to lead to useful improvements in an operational system in the near term. While there are many possibilities for significant improvements in modeling structures through the use of the new regional systems models, the extension of these models to the issues required for detailed environmental analysis would be a considerable undertaking.[2]

An option open to the SEAS designers is to use county activity projections from either Harris' Multiregional, Multi-Industry Model or ORNL's MULTIREGION model.3 Within the current framework of SEAS, projections from either model could be incorporated easily by developing appropriate "share" files. Since both of the models can use INFORUM4 as a national driver, consistency of the regional projections with the SEAS national projections would be maintained. Such an approach would provide, if not better regional activity projections, at least alternatives to the current OBERS shares.

However, it is not clear that such a strategy would improve the credibility of the regionalization scheme used in SEAS, nor the usefulness of SEAS projections for detailed regional analysis. Any improvements in the regional activity projections are likely to be obscured by working these data inputs through the other SEAS modules. Why this is likely and what I feel is the cause of the lack of "credibility" of the current SEAS system will be discussed below.

The current SEAS modular structure makes it difficult to accommodate emerging models in a useful manner. The regionalization approach, which relies on sharedown methodology, places severe limitations on the SEAS framework and hinders improvement of its usefulness for detailed regional analysis. While complete and consistent documentation of each of the component modules (and techniques) is the first step necessary for communicating the strengths and weaknesses of the SEAS projections, it is not likely to be a final solution.

The specified objective of the current workshop is to address possible improvements of the "regionalization" of SEAS national projections. However, this is likely to be interpreted by some participants as developing a more sophisticated regional systems model to replace the current model's approach of using OBERS projections to share national activity. I feel that this is not likely to be a fruitful initial step in the process. Prior to examining existing regional system models, soon to be developed models, or the ideal type of regional model which could be built from scratch, it is necessary to consider what information the SEAS system is intended to supply and should provide in order to aid in regional impact analysis. Only then can one consider how "ideal" projections of basic regional economic activity can be usefully integrated into the SEAS system.

Several basic background issues need to be considered by the workshop in order to put in perspective the potential role of incorporating any new modeling technique in the SEAS system. The purpose of this paper is to raise these issues and, hopefully, to stimulate discussion.

The following issues, while quite simple, need to be considered in detail before much progress will be made. The present paper will focus on the first of these questions leaving the others for open discussions.

- What should be required of a Regional Strategic Environmental Analysis System?

- What are the important regional, economic, energy, and environmental issues which need to be addressed?
- How might we model these issues in the current SEAS framework and provide a base for detailed regional analysis?
- What might we expect from regional systems models in the future and how can the SEAS modular design be structured to incorporate new developments in regional modeling as they arise?

WHAT SHOULD BE REQUIRED OF A REGIONAL STRATEGIC ENVIRONMENTAL ANALYSIS SYSTEM?

Often the desired or articulated goals (and indeed the policy needs) of any modeling system are beyond the bounds of the current state of knowledge and technique. The broad goals often expressed for the SEAS system, and alluded to by Paul Schwengels in his opening statement, are near (if not beyond) such limits. The first step in any modeling strategy is to acknowledge our current limitations and explicitly state such limits. Only then can we make consistent progress toward improvements in our understanding and our ability to model complex systems.

Much of the skepticism which has developed about the SEAS approach seems to be derived from two sources. First is the lack of consistent and complete documentation of the goals, methods, and limitations of the regional projections.[5] Second is the nature of the expansion of the system from a national to a purportedly detailed regional analysis system. While the serious regional analysis of any relationship is complex and fraught with uncertainty and limitations in modeling capabilities, the interactions of the socioeconomic, energy, and environmental systems are especially complex. These potential interactions are something we know very little about. The inference an outsider to the SEAS system draws, is that the developers believe they possess capability which most practitioners would feel is beyond the state of the art.

To a certain extent the overall SEAS program has been affected by a variant of Gresham's Law: The poorly conceived extensions (modules and claims) have drawn emphasis away from the better and more acceptable ones. Thus, the first general issue which needs to be formally discussed is what goals can be realistically set for a "regional" SEAS system.

What Should the Regional SEAS System Do?

The original design goal for the SEAS system, as reported by Joseph Coates in his review of technological assessment models (1972), was "the projection of economic demographic variations and their impacts on pollutant residual levels."[6] Additionally, the indirect and feedback response system of environmental policy on socioeconomic trends was to be modeled and investigated.[7] While a formal modeling structure was developed for national projections, the regional component was developed as an informal sharedown methodology of the national residuals. The regional module appears to be a "tack on" as seen in Figure 1.[8]

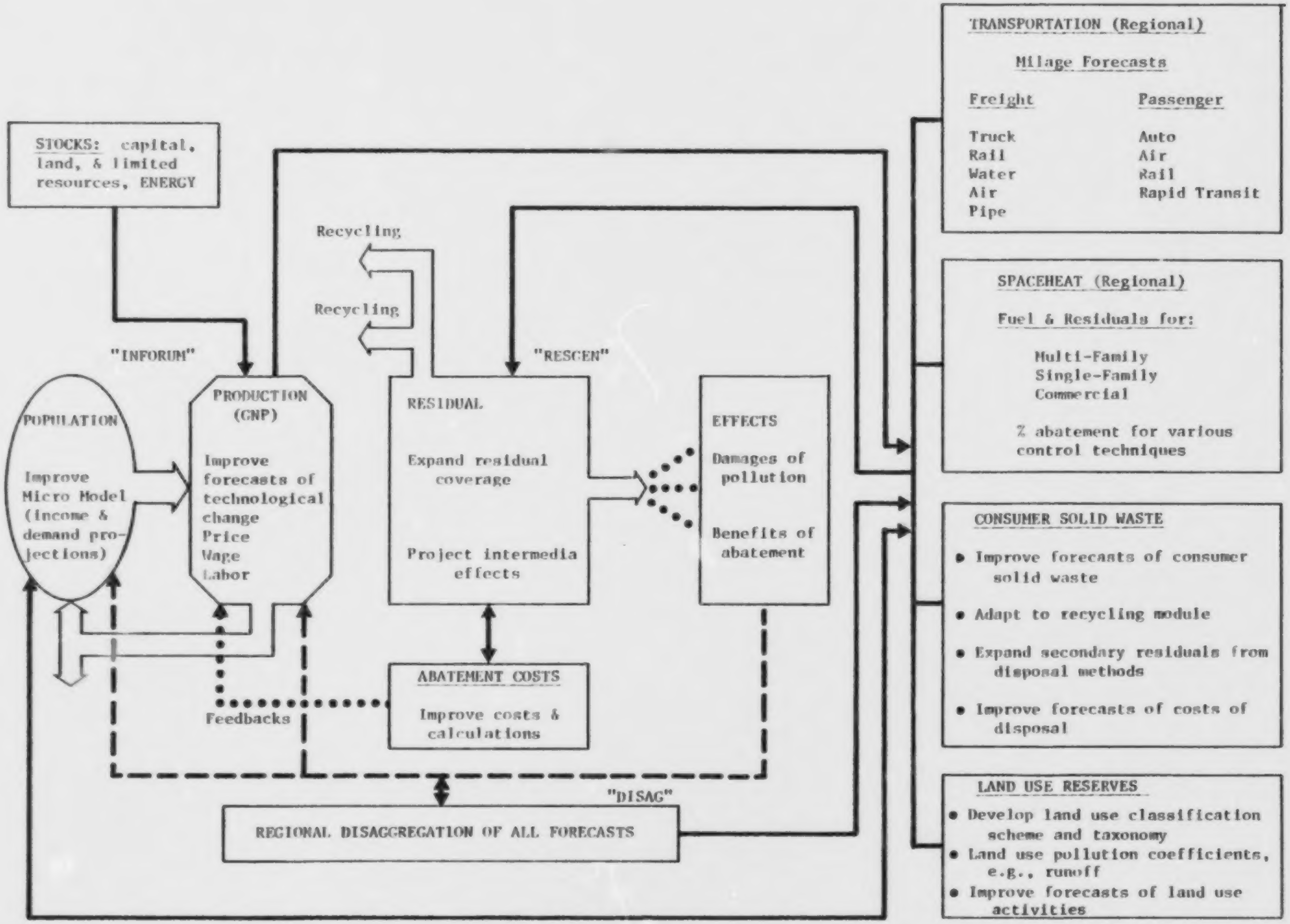

STOCKS: capital, land, & limited resources, ENERGY
"INFORUM"
POPULATION
Improve Micro Model (Income & demand projections)
PRODUCTION (GNP)
Improve forecasts of technological change
Price
Wage
Labor
Recycling
Recycling
"RESCEN"
RESIDUAL
Expand residual coverage
Project intermedia effects
EFFECTS
Damages of pollution
Benefits of abatement
ABATEMENT COSTS
Improve costs & calculations
Feedbacks
"DISAG"
REGIONAL DISAGGREGATION OF ALL FORECASTS
TRANSPORTATION (Regional)
Milage Forecasts
Freight
Truck
Rail
Water
Air
Pipe
Passenger
Auto
Air
Rail
Rapid Transit
SPACEHEAT (Regional)
Fuel & Residuals for:
Multi-Family
Single-Family
Commercial
% abatement for various control techniques
CONSUMER SOLID WASTE
• Improve forecasts of consumer solid waste
• Adapt to recycling module
• Expand secondary residuals from disposal methods
• Improve forecasts of costs of disposal
LAND USE RESERVES
• Develop land use classification scheme and taxonomy
• Land use pollution coefficients, e.g., runoff
• Improve forecasts of land use activities

FIGURE 1
STRATEGIC ENVIRONMENTAL ASSESSMENT SYSTEM
(SEAS)

The ensuing years have seen a growth in the system that includes an energy consumption module and more emphasis on a variety of regional energy facility "siting" components.[9] This is seen in the recent diagram released by SEAS and shown in Figure 2.[10] With the exception of energy siting modules, the regional components still appear as an informal stepchild of the more structurally detailed national model.

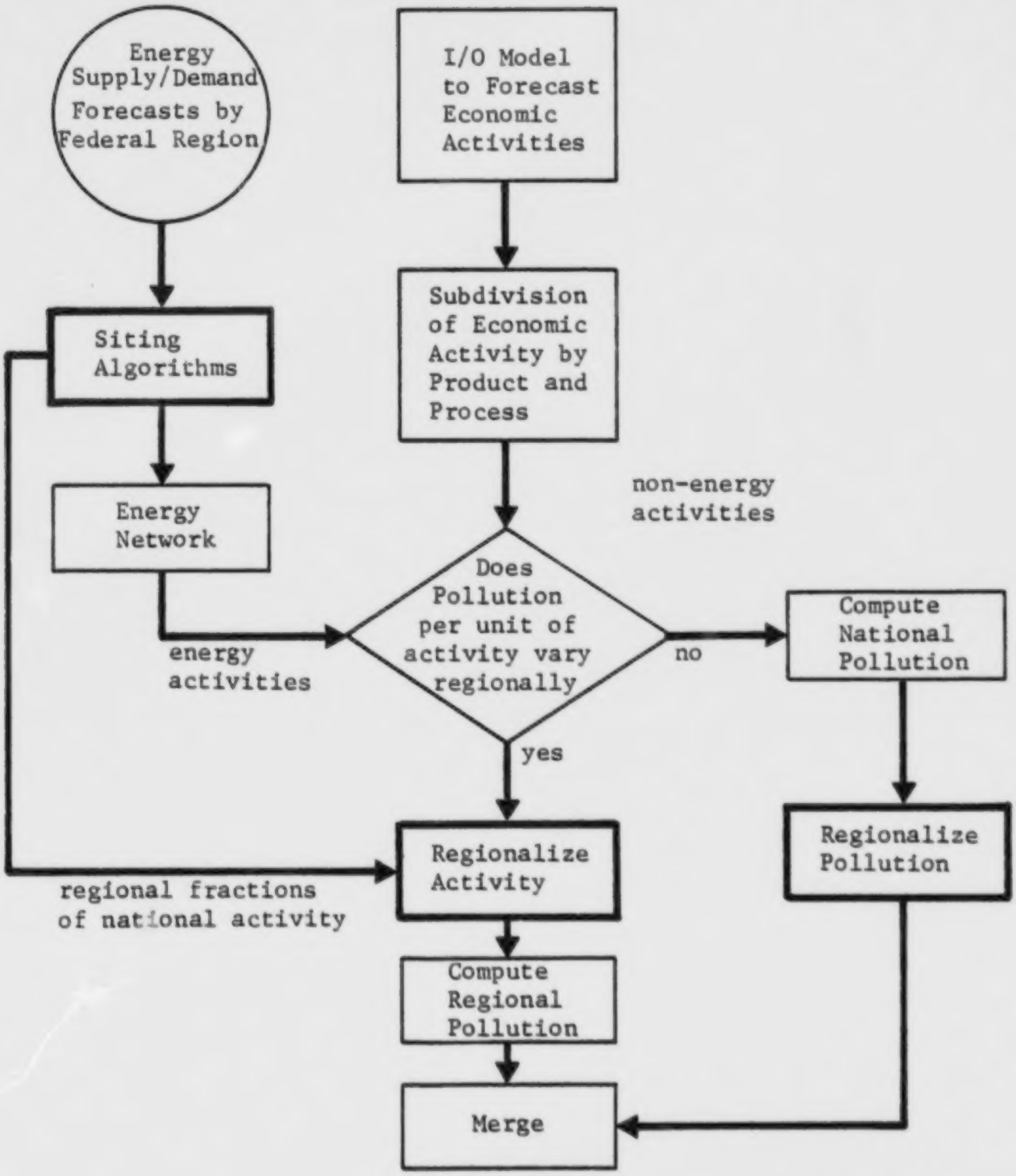
Recent uses of the model by Department of Energy (DOE) have explicitly attempted to investigate the nature of the regional environmental impacts of alternative energy and environmental policy initiatives.[11] The need for the analysis of environmental policy to be addressed with alternative energy policies has required the SEAS system to be constrained to "extraneous" energy policy models. Thus, the evolving issues of energy and environment have developed the requirement that the system should be able to address in a credible way:

(1) The regional environmental impacts of current (or alternative) national and regional trends in socioeconomic activity, given energy and environmental policy.

(2) The possible changes in the levels of environmental impact due to alternative energy and environmental policies, given the socioeconomic trends.

(3) The indirect effects on regional socioeconomic trends due to alternative energy and environmental policies.

The third area of investigation, potential changes in socioeconomic trends, may be broadly classified into three types of responses


Energy Supply/Demand Forecasts by Federal Region
I/O Model to Forecast Economic Activities
Siting Algorithms
Subdivision of Economic Activity by Product and Process
Energy Network
non-energy activities
Does Pollution per unit of activity vary regionally
energy activities
no
Compute National Pollution
yes
Regionalize Activity
Regionalize Pollution
regional fractions of national activity
Compute Regional Pollution
Merge

RELATIONSHIP BETWEEN REGIONALIZATION AND OTHER SEAS FUNCTIONS

FIGURE 2
CURRENT SEAS REGIONALIZATION

to changes in environmental and energy policy. The first, and simplest to model, are the induced and indirect effects generated by energy supply changes (e.g., energy facility siting or coal development). A second type of regional response comes from changes in the level and composition of national economic activity. Generalized growth or decline in various sectoral growth rates at the national level may cause differential regional responses. The third, and most difficult area to model, is the long term changes in regional comparative advantage which comes about because of changes in the relative regional impacts of energy and environmental constraints.[12] For example, will the South have a greater comparative advantage than it has historically because of the regional availability of energy supplies?

All of the major topics presented above relate to potential structural changes in the determinants of regional activity, energy use, and derived environmental impacts. In order to investigate the regional impacts, potential changes, and their likely determinants (i.e., the potential impact of regional environmental and energy changes), it is necessary to examine these structural changes. To evaluate the importance of projected regional impacts of national energy and environmental policy, it is as important to see how the model arrived at a projection of the residuals as it is to see the absolute level of the projected residuals.

What are Generalized Model Requirements for Impact Analysis?

The need to be able to explicitly trace the causes and linkages which result in a particular level of residuals (rather than the absolute level itself), suggests why the current implementations of the SEAS regionalization (sharedown) procedure is inadequate for regional impact analysis. It is not possible, given current output, model description, and input documentation, to trace through the determinants of a particular pollutant level in any selected region.

The lack of a structural representation in the sharedown approach presents three practical difficulties in assessing the importance of any projected change in environmental residuals. First, we cannot identify if a particular result might be due to our ignorance of existing conditions (or how such inaccuracies might be compounded by merging several inconsistent data series within the current modular framework).[13] Second, we are not able to clearly establish the impact of the assumed (or modeled) growth in regional economic activity as a contributing force to changes in the level of residuals. And finally, we cannot define explicitly how various assumptions on energy and environmental (constraints) policies are incorporated into the projections structure. In effect one cannot distinguish whether any particular significant change in a projected residual level is due to errors in base year data, changes in underlying regional growth, artifacts of the model, or the investigated changes in environmental or energy policies.

The above considerations give rise to a second set of model requirements -- to provide sufficient information for broad based regional analysis.

(1) A consistent set of initial conditions should be established.

A comprehensive base year file should be developed which relates economic activity, energy consumption (and fuel choice), and environmental loadings. This file should be structured with information presented at the finest level of regional and sectoral definitions required for any ultimate policy impact analysis. With the existing quality and limited comprehensiveness of regional economic, energy, and environmental data, such a data series can provide only a "reasonable" approximation to the state of the world in the base year. While there is the need to provide as accurate a picture as possible of existing (initial) conditions, effort in this direction must be balanced with the need to show the relationship between the various components of the initial conditions. For example, the very detailed data on boilers from the Major Fuel Burning Installations File[14] (MFBI) may not be useful for long term analysis, unless we can relate fuel consumption to industrial output by sector. Most important, this base data series should be provided (in detail) with the projections to users of the regional forecasts. Each user may then determine if any "particular" projections are in part determined by inadequate or incomplete information on the assumed state of the "region of concern" in the base year.

(2) An initial set of energy and environmental parameters should be identified.

While the level of each variable under consideration is provided in the base data file, it is also desirable to explicitly state the relationships between each of the variables. For example, initial base year values for energy consumption per unit of activity by region and sector should be estimated. Similarly, residuals generated per unit of BTU consumed by a particular fuel should be provided and documented. Such coefficients may be estimated in the simplest case as ratios observed in the historic data series. More generally, one would like to establish a functional relationship of these coefficients to important determinants which could vary over regions, sectors, and time. Per capita energy consumption in the residential sector, for example, could be empirically related to per capita income, real price of energy, regional heating degree days, level of urbanization, and other relevant regional variables.[15]

(3) An explicit structure should be articulated.

A simplified structure which relates each of the components in the chain between the level of economic activity, energy consumption, pollution, and abatement levels should be defined and made explicit. In the simplest case such a structure may be a simple multiplier format (see below). With a more formal model, interrelationships or simultaneous relationships may be incorporated. However, the purpose of the explicit structure is to allow a researcher to follow the assumed chain of events which determine the level of residuals projected by a particular scenario.

(4) An explicit statement of how a given energy and environmental policy constraint changes the initial parameter should be developed.

Many uses of the projections framework are likely to involve constraints to other models (for example, Midterm Energy Forecasting System (MEFS),[16] or policy assumptions on coefficients (i.e., Best Available Technology assumptions). These constraints or assumptions should be interpreted explicitly in terms of the changes in parameters of the model.

(5) A consistent set of projected variables should be generated.

Rather than the current practice of just providing the total level of regional pollutants, a complete set of regional projections of all variables (i.e., economic activity, energy consumption by fuel type, and residual loadings) should be generated. These projections series should be provided at the same sectoral/regional level of detail as the base year file. Such a detailed file will allow a researcher to trace how each component in the projections file was derived from the base file.

(6) Summary tables should provide information useful to regional and national policy analysts.

Because the detailed projections are not likely to be required for all potential users (although they may be required as backup documentation to investigate particular regional impacts) a system of table generators should be developed to rearrange or aggregate the basic data in the detailed files. The nature of these summary files needs to be tailored to the requirements of the intended users. Often the regional reporting grid of spatial data useful for policy analysis is not the appropriate grid for modeling. When feasible, the regional grid for modeling should be an appropriate functional unit and final projections should be remapped to useful reporting aggregates. Having a consistent, very detailed, projection data series can provide a base for a wide variety of potential users requiring information by different spatial concepts.

The majority of these points are incorporated in most modeling efforts and are followed in the Inforum Module. However, when the practical problems associated with large regional models (and data series) are encountered, simplifications are often used to economize on data processing. This is the case with the sharedown approach used in SEAS. This particular choice for simplification, however, prevents one from tracing through the cause and effect of model components. It would be much better to assume a simple model structure (at least initially) and process the data at a level of detail required for complete analysis of the model results. In the past, processing such a volume of data may have been a significant computational burden but this is no longer a constraint.

Figure 3 outlines the generalized structural requirements suggested by the six steps discussed above. This structure should provide sufficient information for investigating outputs of the model

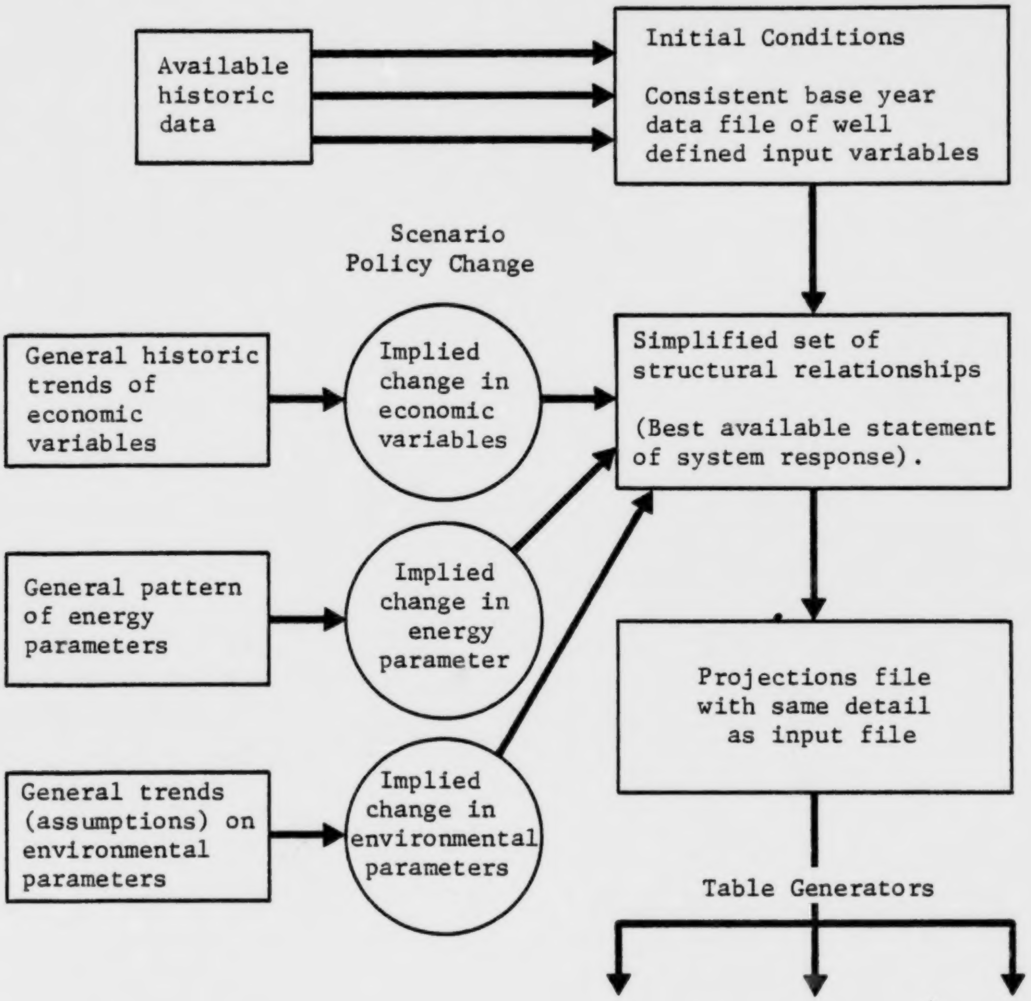

Available historic data
Initial Conditions
Consistent base year data file of well defined input variables
Scenario Policy Change
General historic trends of economic variables
Implied change in economic variables
Simplified set of structural relationships
(Best available statement of system response).
General pattern of energy parameters
Implied change in energy parameter
Projections file with same detail as input file
General trends (assumptions) on environmental parameters
Implied change in environmental parameters
Table Generators

FIGURE 3
GENERALIZED MODEL REQUIREMENTS FOR
REGIONAL IMPACT ANALYSIS

and determining the cause of regional change. Formally articulating the structure of the model and input data bases also provides a mechanism for developing consistent improvements in these components, when new information or research becomes available.

Accuracy, Credibility and Accountability: Suggested Short-Term Goals for SEAS Improvement.

The issues which are likely to be addressed in any policy exercises of the model will necessarily be complex and imperfectly modeled. If we were considering simple problems, we would use a much less resource demanding approach than a SEAS type model. Although one may strive for "accuracy" in input (historical) data, it is unclear what accuracy in scenario projections should mean. The analyst is most likely concerned with potential structural changes in the underlying system and how these structural changes might affect general trends. Thus, one is concerned with likely or plausible responses to policy options.

In estimating such responses at a regionally detailed level (e.g., county), the most realistic goal is to project reasonable or likely responses in the system to the exogenous policy changes. The myriad of region specific factors relating the energy choices, environmental issues, and economic/demographic interactions can not be modeled with precision. The projections of such a system should not be taken as a prediction of the future, but rather as an indicator of potential change. One, therefore, needs to articulate carefully the criteria which should be used to evaluate the overall strength of such a model or system of models. Much of the current discussion about improvements in SEAS has referred to "credibility," presumably relating to both model components (i.e., consistency of linkages between component modules[17] and reasonable methods for regionalization) and projections (i.e., reasonable projected values given initial conditions). These are desirable goals and should be pursued; however, there is a third factor to consider before one can establish linkages to a regional systems model or develop usable results for impact analysis. While "unreasonable" values or outliers are often easy to identify, their cause in the current SEAS system is not. Accountability needs to be included as a key criteria for making SEAS projections useful for impact analysis.

This suggests that immediate or short term improvements can be made to the system by:

1. Establishing a consistent base file
2. Simplifying and making explicit the assumed relationships used in projections
3. Developing a consistent projections file with a regionally detailed set of relevant variables

These three extensions would satisfy the basic model requirements discussed in the previous section. Developing these capabilities may seem to be a difficult task, but they can be accomplished within the current modular approach without too much difficulty. Much of the information that went into building the series of share files could be used in estimating the base year file. With the base year file explicit, it may be examined for "accuracy" and be corrected (such work has been done by ORNL for DOE on the utility sector data).[18] In several of the siting modules, the projection files are already generated, but they are transformed into share files. Consequently, useful information for impact analysis is not passed on to users.

The generalized model requirements stated above do appear in one recent addition to the SEAS system: the Coal Mining Module.[19] While the basic approach to projecting future county coal production is quite simple it is well defined and straight-forward. The documentation presents base year data and a clear presentation of the projection algorithm. In addition, the outputs from the module are in the form of a projections file. In other modules, however, the interaction between underlying base data and constraints from other modules (or other models) becomes less clear. A simple example will be presented to show how a slight reformulation of one such module may provide more useful output to a regional analysis.[20]

A Simple Reformulation of a SEAS Sharedown Procedure.

The Industrial Fuel Use Module was, in part, developed to allocate Federal Region energy projections from the MEFS system to states. A second step is then performed to allocate the state projections to counties. The problems implicitly addressed in this procedure involve changes in regional economic activity, energy growth, and fuel choice. The fact that MEFS develops regional energy demands using a different set of regional activity forecasts than the OBERS projections used in SEAS presents a consistency problem. However, the following heuristic example will abstract from most of these technical, "theoretical," and empirical difficulties.

The basic problem we will consider is the allocation of a given Federal Region total energy projection to the constituent states. The current SEAS procedure is to modify each state's base year energy consumption by the OBERS growth rate and then share the Federal Region total accordingly.[21] The approach may be expressed as:

$$E_{it} = \delta E_{it_o} (1+g_i)^n \lambda$$

where

i = state

t = projection year

t_o = base year

$n = t-t_o$

E_{it} is the (projected) energy consumption for state i in year t.

Base year (t_o) energy consumption data are modified values from the DOE/FEDS data system.

g_i is the average annual growth rate of economic activity (obtained from OBERS earnings projections for the manufacturing sector) for state i.

λ is an adjustment factor to capture the average energy consumption changes relative to activity changes in the Federal Region.

$$\lambda = \frac{\text{energy growth in Federal Region (from MEFS)}}{\text{activity growth in Federal Region (from OBEFS)}}$$

δ is a normalization parameter to assure that the state projections sum to the Federal Region total

$$= \frac{\text{Federal Region total energy in t}}{\sum_i E_{it_o}(1+g_i)^n \lambda}$$

In the current procedure, the only information that is presented in SEAS output is the base year and the projected year energy total. Often it is difficult to interpret the significance of a change. An equally simple approach, using the same information as the above, but presented as a structured relationship in which the importance of the Federal Region constraint is made explicit, can be developed as follows: let

$$E_{it} = e^*_{it} A_{it}$$

where

$A_{it} = (1+g_i)^n A_{it_o}$ an explicit projection of activity in state i

e^*_{it} is the projected energy per unit of activity implied by the scenario constraint

The projected energy per unit of activity is defined as:

$$e^*_{i,t} = \gamma e_{it_o}$$

where

$$e_{it_o} = \frac{E_{to}}{A_{to}} = \frac{\text{base year energy consumption}}{\text{base year activity}}$$

and $\gamma = \dfrac{\text{Federal Region total energy consumption in t}}{\sum_i e_{it} A_{it}}$

The adjustment parameter γ can easily be shown to be equal to λ times δ.

It should be recognized that this second method hasn't improved the overall methodology. A strong set of heroic assumptions are

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It should be recognized that this second method hasn't improved the overall methodology. A strong set of heroic assumptions are still invoked: the (independent) projections of economic activity are not altered by the changes in energy policy and the energy intensity of industries in all states has the same relative change. This approach, however, shows explicitly how the energy scenario change is incorporated into the regional projections.

The information which can be supplied to the regional analyst is:

1. Base year and projected economic activity
2. The change in energy intensity implied by the energy scenario
3. Base year and projected energy consumption

Figure 4 presents this example in the framework described earlier. The structural approach, moreover, can be designed to use an explicit set of economic activity projections rather than imputed growth rates. Operationally, developing the projections file becomes quite simple. The projected energy intensity coefficient (γ) computed by the Industrial Fuel Use Module, is simply multiplied times the base year energy coefficient and then is multiplied times the projected activity. This is a simple computer task given the base year activity file. Providing this extra step, however, can make the regional projections much more useful and interpretable for regional analysis.

This simple example has ignored most of the difficult issues, but the general procedures can be extended to these as well. Fuel switching assumptions from the Industrial Fuel Use Module can be incorporated by a fuel share parameter. Similarly, an explicit

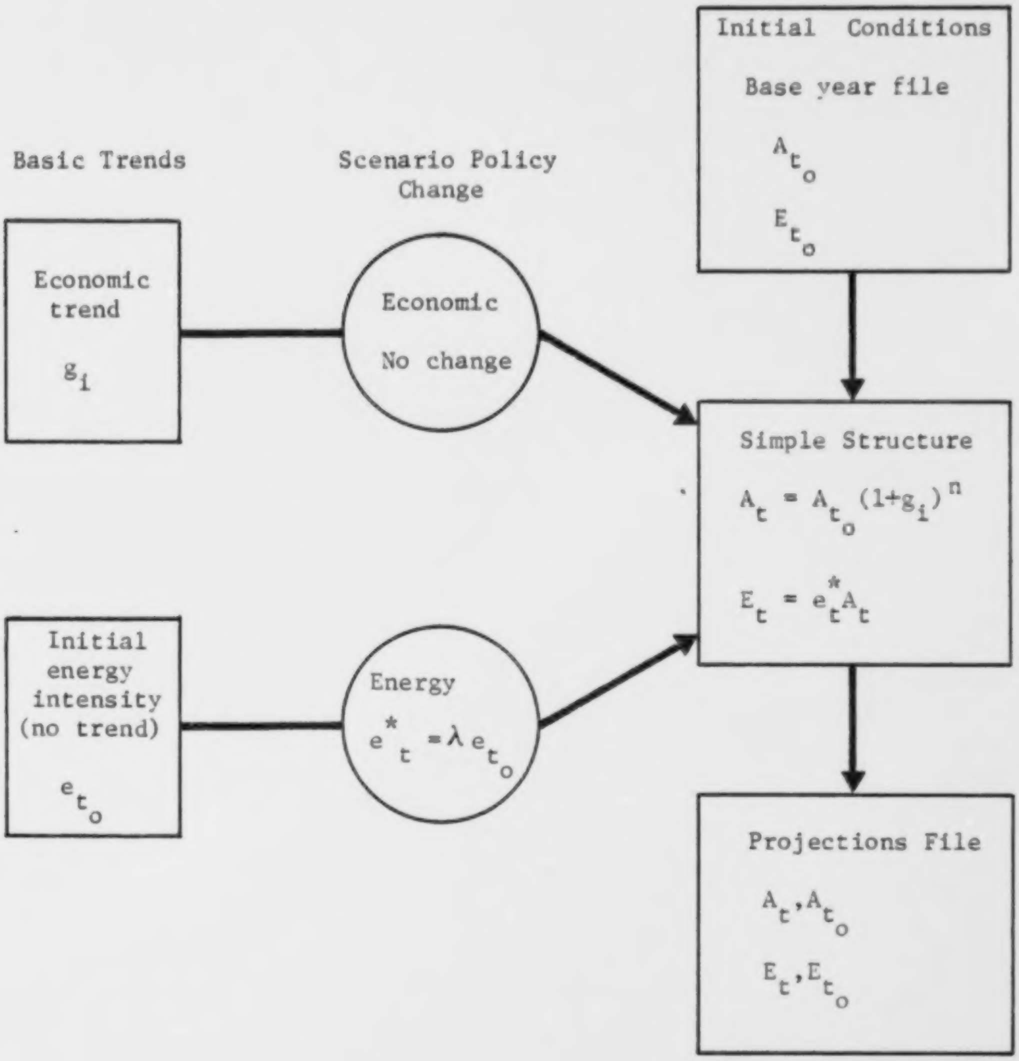
Basic Trends
Scenario Policy Change
Initial Conditions
Base year file
A_{t_o}
E_{t_o}
Economic trend
g_i
Economic
No change
Simple Structure
$A_t = A_{t_o}(1+g_i)^n$
$E_t = e^*_t A_t$
Initial energy intensity (no trend)
e_{t_o}
Energy
$e^*_t = \lambda e_{t_o}$
Projections File
A_t, A_{t_o}
E_t, E_{t_o}

FIGURE 4
STRUCTURAL REPRESENTATIONS OF
THE REFORMULATED FUEL USE MODULE

treatment of "old" plants versus new capacity (activity) may need to be articulated with separate energy coefficient assumptions. More difficult is reconciling the information from the MFBI file which is used to allocate the state totals to counties. An extension of the above approach using a refined base year file which relates the data in the MFBI file to economic activity should prove more useful than the current strategy.

The structural approach may also be used to project environmental residuals. Figure 5 outlines a simple structure which relates a projected level of economic activity to residual generation. To estimate the residuals for a given activity, we need to know the level of activity, process involved, pollutant loadings of fuel used, and abatement level.

A simple multiplier approach representing this sequence for the case of boiler fuel used in an industrial activity is shown in Figure 6. To project regional residuals, we estimate or assume implicitly some value for each of these parameters. The interesting thing is that energy and environmental policies are likely to influence all parameters. Therefore, we should explicitly state our assumptions of how we think these parameters will be adjusted as a result of the energy and environmental policy being examined.

The initial value of the parameters and their changes may vary over regions and over time as a function of regional characteristics (e.g., energy prices, fuel availability) or of policy (e.g., Best

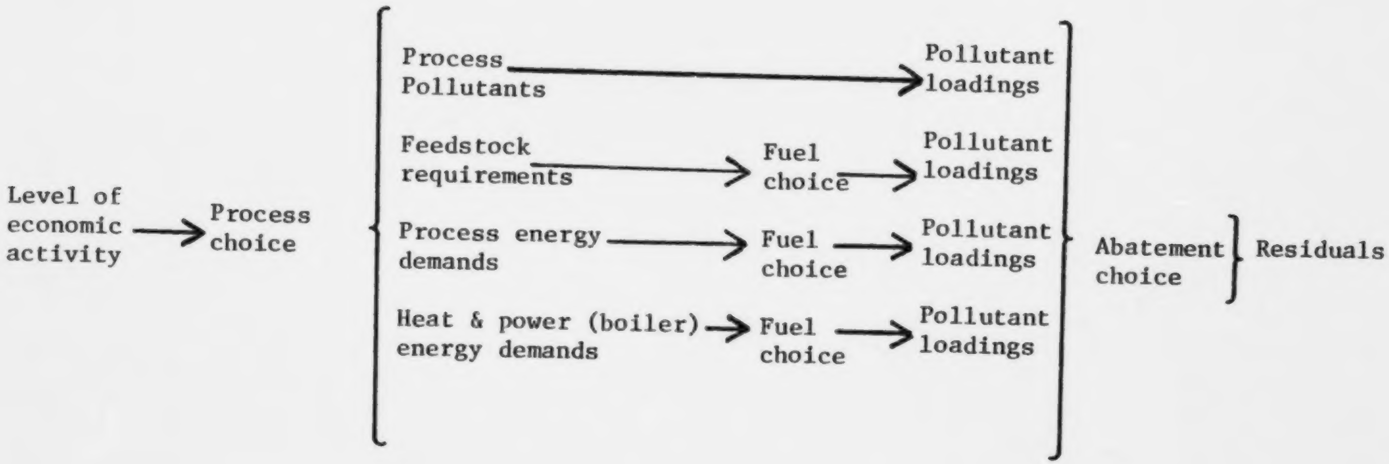
Level of economic activity
Process choice
Process Pollutants
Pollutant loadings
Feedstock requirements
Fuel choice
Pollutant loadings
Process energy demands
Fuel choice
Pollutant loadings
Heat & power (boiler) energy demands
Fuel choice
Pollutant loadings
Abatement choice
Residuals

FIGURE 5

A SIMPLIFIED STRUCTURE OF THE DECISIONS GIVING RISE TO LEVEL OF RESIDUALS

$$R_{ijklm} = (1-a_{ijklm})\ (P_{ijklm})\ (s_{ijkl})\ (e_{ijk})A_{ij}$$

where

i = sector

j = region

k = fuel use (process)

l = fuel type

m = residual type

R_{ijklm} = the residual loadings of pollutant m from fuel type l used in process k of activity sector i in region j

A_{ij} = the level of activity of product (sector) i in region j

e_{ijk} = the level of total energy demand per unit of activity for process k in region j of sector i

s_{ijkl} = the share of total energy provided by fuel type l $(0<s<1)$

p_{ijklm} = the level of pollutant per BTU in fuel l, residual type m

a_{ijklm} = the required (or economic) abatement level on residual m from fuel l in region j for sector i and process k (if a is the relative abatement level, where $0<a<1$, then $(1 - a)$ is the share of pollutants released to the environment.)

FIGURE 6

A PARAMETIZATION OF SIMPLE STRUCTURE RELATING RESIDUALS TO ECONOMIC ACTIVITY

Available Central Technology - BACT). How these parameters might change and what factors determine these potential changes are the real research questions which need to be addressed. Until we can formalize such information, however, it is best to make simple assumptions about these changes and to keep these "estimates" explicit. A diagram for extending the current SEAS regionalization procedure (Figure 2) to include explicit scenario parameter assumptions and a regional projection file is presented in Figure 7.

The incorporation of the projection file and the explicit treatment of scenario constraints have other important advantages. Explicitly establishing the linkages between the component modules is a necessary step before SEAS can incorporate a Regional System Model in an integrated and consistent manner.

Incorporating a Regional Systems Model in the SEAS System: The Intermediate Term

The articulation of an explicit structure sets the stage for incorporating one of the current or developing regional systems models. Having a well defined base file on economic activity (value added, employment, etc.) would create the opportunity to establish the link between one of the Regional Systems Models and the rest of the SEAS system. Current SEAS practice of using separate modules for the siting of energy supply activities -- coal mining, electric utility, new technologies, etc. -- should be maintained. For most analytical purposes, the regional activity due to energy supply patterns

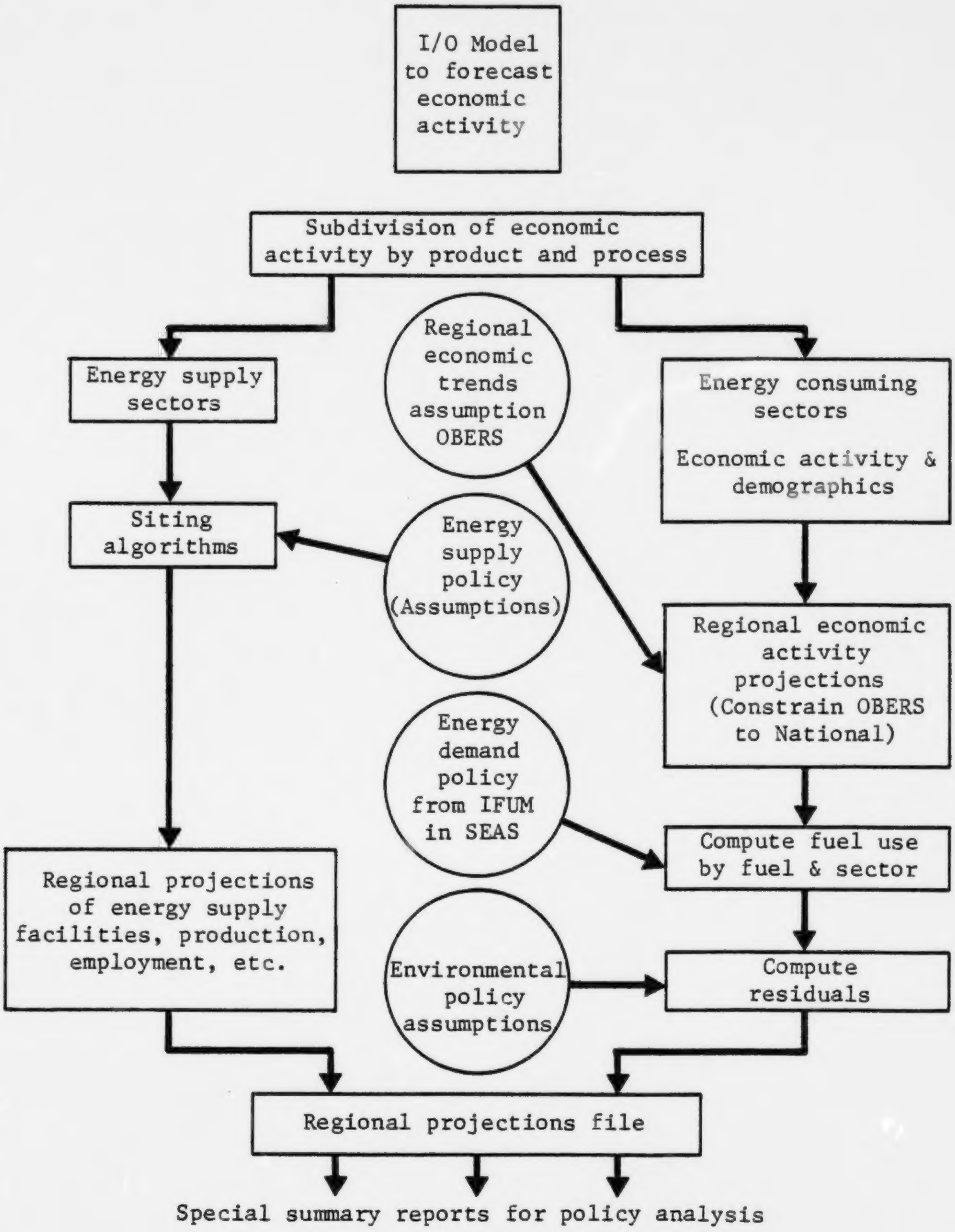
I/O Model to forecast economic activity
Subdivision of economic activity by product and process
Energy supply sectors
Regional economic trends assumption OBERS
Energy consuming sectors
Economic activity & demographics
Siting algorithms
Energy supply policy (Assumptions)
Regional economic activity projections (Constrain OBERS to National)
Energy demand policy from IFUM in SEAS
Regional projections of energy supply facilities, production, employment, etc.
Compute fuel use by fuel & sector
Environmental policy assumptions
Compute residuals
Regional projections file
Special summary reports for policy analysis

FIGURE 7
REFORMULATED SEAS REGIONAL PROJECTION MODEL

can be taken as an exogenous policy or assumed condition in the projections of other sectors.

Additionally, large energy consuming or polluting industries which operate in national markets can be selected out for special consideration. Initially, these may be handled by a share approach, which is the current method. Eventually, it would be desirable to incorporate formal industrial location models in order to determine the appropriate spatial patterns of these industries. Current emphasis appears to be on approximately 22,000 industrial boilers in use, although there appears to be some uncertainty concerning the location of 16,000 boilers.[22] One estimate made by ORNL is that 4,000 large energy using manufacturing plants consume about 70 percent of the energy used in the manufacturing sector[23] (see Table 1). With some further analysis, I suspect we would discover that the majority of these are large plants serving national markets and could be adequately handled by a small set of specialized industrial location models.[24] Thus, I suggest the focus should be on projecting future location of these plants using traditional economic locational models, but integrating energy and environmental factors. Then one could estimate energy and boiler requirements based on the projected regional location of these industries. For long-term analysis (1990 and 2000), one should not project boilers independent from a formal industrial analysis. Available regional models are not generally detailed enough to project the regional location for the large plants

TABLE 1

SELECTED CHARACTERISTICS FOR LARGE ENERGY USING PLANTS

UNITED STATES

	CHARACTERISTICS OF ALL PLANTS				CHARACTERISTICS FOR SELECTED LARGE ENERGY USING PLANTS				
							% SHARE RELATIVE TO ALL PLANTS		
SIC	NO FIRMS	EMPLOYMENT	ENERGY 10**12 J	NO FIRMS	EMPLOYMENT	ENERGY 10**12 J	FIRMS	EMPICY	ENERGY
ALL MANUFACTURING	296716.	17237692.	10940997.	4153.	3641927.	7734586.	1.40	21.13	70.69
20 FOOD & KINDRED PROD	24550.	1452444.	824687.	385.	231501.	381669.	1.57	15 94	46.28
21 TOBACCO MANUFACTURE	276.	66214.	16089.	11.	37750.	8808.	3.99	57.01	54.75
22 TEXTILE MILL PRODUCTS	6693.	813740.	228022.	144.	155964.	72769.	2.15	19.17	31.91
23 APPAREL & OTHER TEXTL	22638.	1185550.	26687.	0.	0.	0.	0.0	0.0	0.0
24 LUMBER & WOOD PROD	29943.	568535.	174531.	22.	17506.	9542.	0.07	3.08	5.47
25 FURNITURE & FIXTURES	8529.	395258.	32685.	0.	0.	0.	0.0	0.0	0.0
26 PAPER & ALLIED PROD	5874.	585774.	1163179.	549.	219524.	1036318.	9.35	37.48	89.09
27 PRINTING & PUBLISHING	40713.	1081730.	66414.	2.	2819.	638.	0.00	0.26	0.96
28 CHEMICALS & ALLIED PR	10957.	839158.	2613140.	979.	470144.	2157420.	8.93	56.03	82.56
29 PETROLEUM & COAL PROD	1977.	145464.	1411134.	325.	113154.	1263798.	16.44	77.79	89.56
30 RUBBER & MISC PLASTIC	9425.	587951.	166173.	64.	107111.	58530.	0.68	18.22	35.22
31 LEATHER & LEATHER PRO	2846.	225976.	17125.	2.	1265.	733.	0.07	0.56	4.28
32 STONE, CLAY, & GLASS	15553.	576759.	1138614.	652.	230616.	876172.	4.19	39.98	76.95
33 PRIMARY METALS INDUST	6803.	1156764.	2010345.	505.	705594.	1541818.	7.42	61.00	76.69
34 FABRICATED METAL PROD	28459.	1400633.	293607.	96.	128461.	56480.	0.34	9.17	19.24
35 MACHINERY, EXCEPT ELEC	40620.	2076434.	246854.	144.	322045.	63468.	0.35	15.51	25.71
36 ELEC & ELECTRONIC EQP.	12062.	1572287.	157349.	55.	89298.	24472.	0.46	5.68	15.55
37 TRANSPORTATION EQUIP	8264.	1584009.	283638.	198.	736184.	158399.	2.40	46.48	55.85
38 INSTRUMENTS & RELATED	6079.	517896.	40802.	17.	69120.	21502.	0.28	13.35	52.70
39 MISC MANUFACTURING	14455.	405116.	29922.	3.	3871.	2049.	0.02	0.96	6.85

discussed above. Thus, by separately projecting their location patterns by specialized modules which incorporate energy and environmental parameters, we have simplified our demands from the more general models. In effect, we may assume the projected location and output levels of the energy supply sectors and special industrial plants as exogenous regional inputs to the regional model. One may think of these as basic (export-oriented) industries which locate in regions based on regional-specific factors (access to raw materials, water, favorable energy environmental factors, etc.). Economic activities of the remaining sectors may be viewed as more market-oriented, regionally homogenous, or more locationally responsive to the traditional economic factors (e.g., wages).

The siting and locational models can be used to project relevant economic activity variables that cab be used to initialize the Regional System model. For example, the Coal Mining model could project employment, as well as coal production, by assuming an appropriate labor productivity parameter. These employment projections could be used as an input to a MULTIREGION type model which would estimate the induced impacts due to regional shifts in coal mining activities attributed to an energy supply scenario. An outline of such a framework is presented in Figure 8.

In this framework, we use outputs from the industrial location and energy supply siting modules as input into the regional system models. Regional activity is "solved" around these values providing

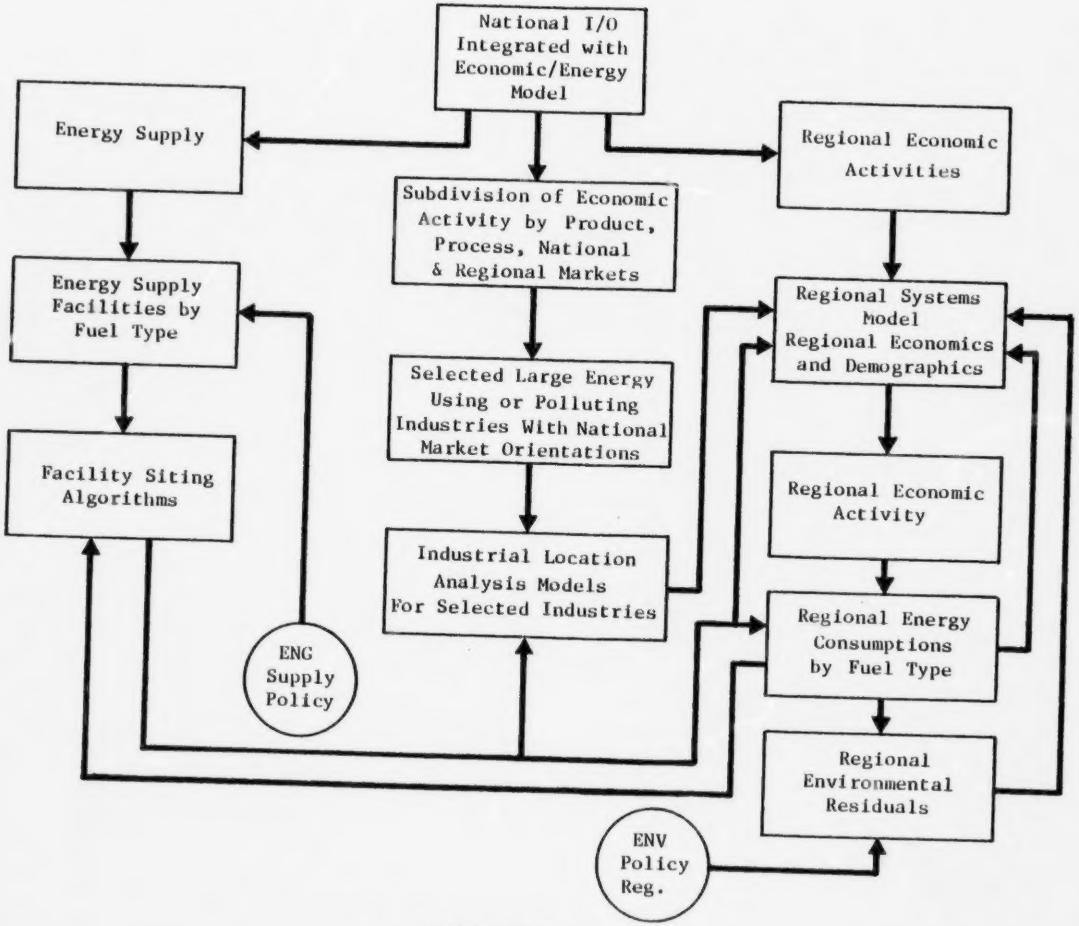
National I/O Integrated with Economic/Energy Model
Energy Supply
Subdivision of Economic Activity by Product, Process, National & Regional Markets
Regional Economic Activities
Energy Supply Facilities by Fuel Type
Selected Large Energy Using or Polluting Industries With National Market Orientations
Regional Systems Model Regional Economics and Demographics
Facility Siting Algorithms
Industrial Location Analysis Models For Selected Industries
Regional Economic Activity
ENG Supply Policy
Regional Energy Consumptions by Fuel Type
Regional Environmental Residuals
ENV Policy Reg.

FIGURE 8
A FRAMEWORK FOR INTEGRATING REGIONAL SYSTEMS MODELS INTO SEAS

regional economic activity for other sectors. It is also possible that the siting and location models could be operated at a finer spatial detail than the Regional Systems model. For example, we may wish to locate plants in particular counties. The activity projected at the county level could be aggregated to BEA and state level. Thus, a Regional Systems model may be incorporated which operates for functional regions on different regional grids than that used in the siting models. Activities which would be projected at the higher regional level are assumed to be more homogenous, more market-oriented, or less important in terms of energy and pollution. If county projections are needed, we could use a simple allocation model to distribute the BEA or state projections to counties. Such a submodel should, however, follow the general procedure outlined earlier. Such a procedure would allow combining models which operate on different spatial scales in a consistent manner to provide the benefits of fine regional detail when needed. It is also possible to incorporate feedback loops from the energy pollutant projections into either the regional model or the siting/location models in an interactive fashion.

It is acknowledged that this discussion has been very general and many technical difficulties exist to incorporate these suggestions. From the users' point of view, the basic suggestions of a consistent set of initial conditions and projections file will provide a decided improvement in the usefulness of SEAS projections.

The additional advantage -- that of establishing a structure which can provide a series of incremental steps which will allow SEAS to incorporate a more formal Regional Systems model -- seems especially compelling.

THE HARD QUESTIONS

The discussion, up to this point, has been only perfunctory to the questions which this workshop needs to explore. The structure suggested in the second section has provided a series of simple steps which will improve the SEAS framework in the short term. In addition, a space can be opened up for integrating a Regional Systems module into the SEAS framework over a longer time horizon. Even the final structure described can answer only a limited number of regional questions. For example, if we put the current version of MULTIREGION in the Regional Systems Block, industrial location and demographic changes would be unresponsive to energy and environmental policy, except as exogenously assumed in the specialized modules, or through changes in the composition of national economic activity. While this would be an improvement over the current approach, there are many important questions which MULTIREGION or other existing models will not be able to address.

It is feasible that the "open space" should be filled by a set of different regional systems models. Each of the current regional models has design features which allow it to address some question the others do not. For example, issues involving state taxation might better be handled using BEA's model,[25] while long-term demographic and employment trends could be addressed with ORNL's MULTIREGION.

At this point, we need to return to the set of questions which I suggested this workshop should address:

a. What are the important regional issues which will be influenced by national energy and economic policy?

b. What can existing regional models do, what are likely developments in regional models, and how can these models be integrated into the SEAS modular framework in a consistent way?

The purpose of raising the first question is not to suggest that the conference develop the list of relevant issue areas. The participants in this workshop are very familiar with the wide range of questions relating to regional economic growth, energy, and environmental policy. The workshop should help define an explicit format in which issues can be formulated and addressed in the SEAS modeling structure. In particular, can we define the nature of the potential sequence of impacts which is likely to ensue?

For example, it would be useful, when one has defined an important specific issue, to place its impact within the following framework:

1. Can we characterize the primary aspects of energy/environmental policy as either short term or long term?
2. At what spatial level does an impact sequence need to be modeled in order to capture the sequence of direct, indirect, and feedback (simultaneous) responses?
3. Are intraregional or interregional interactions of primary significance?

While most energy and environmental issues will interact over most dimensions of the above categories, it is useful to sort out the primary impacts in order to make any analysis tractable. To aid in this sorting process, the issues matrix sketched out in Figure 9 is useful. The matrix structure attempts to present a framework that categorizes the type of responses which should be investigated. The simple example matrix is presented to elicit comments from the workshop on the potential for such a taxonomy of key issues.

When one can characterize an issue in terms of the dimensions of its important impacts and at what spatial level they are likely to be observed, then one can consider a modeling matrix which would indicate what type of tool can best examine a given type of response. An initial attempt at categorizing the regional tools is presented in Figure 10. This taxonomy is quite tentative and is presented only to suggest its usefulness. Perhaps by using this framework, the workshop can identify which kinds of issues would require a formal regional systems model.

Regional analysts and modelers tend to become (like their models) focused with either a short- or long-term perspective. Which questions can and should an integrated model attempt to answer? For example, if one's interest is in the likely impacts of the Fuel Use Act in the short term (5 years), a 1985 forecast from either the current SEAS procedure or an improved version is most likely an inappropriate tool. A more fruitful research strategy would probably

Concern / Unit of analysis	Policy Action	Subsystem	Initial Response	Direct Impacts	Indirect Impacts	Induced Effects	Feedback Effects	Primary Perspective and Area of Concern
Individual behavioral unit		Economic Technology Energy Environment						Local and Technological
Regional Aggregative Analysis		Economic Technology Energy Environment						Regional Short-Terms
Multi-Regional Systems Analysis		Economic Technology Energy Environment						Integrated Long-Term Impacts Growth & Development

FIGURE 9

ISSUES MATRIX FOR THE ANALYSIS OF THE VARIOUS IMPACTS OF ALTERNATIVE POLICIES ON THE REGIONAL ECONOMIC, TECHNOLOGY, ENERGY AND ENVIRONMENTAL SYSTEMS

Concern / Unit of analysis	Policy	Initial Response	Direct Impacts	Indirect Impacts	Induced Effects	Feedback Effects
Individual Behavior Unit		Engineering cost models	Multiplier analysis	Extended multiplier (RIMS)	Export base multiplier analysis Impact Studies	Ad-hoc Techniques
Regional Aggregative Analysis		Behavioral assumptions	Simple econometric allocations (shares)	I/O Models	Income multiplier models Export base Models	Simultaneous equations Econometric Models
Multi-Regional Systems Analysis		Behavioral assumptions	Shift Share	Interregional I/O Models	Multi-Regional Models	Hybred Models (1) BEA Model (short-term)

FIGURE 10

REGIONAL ECONOMIC MODEL TYPES AND ISSUES WHICH THEY ADDRESS require the detailed data in the MFBI file, which could identify industrial plants (and their current locations) which will be required to switch fuels. Further analysis, using industry-specific information, would be required to identify industries that are likely to seek exemptions under the "economic hardships" clause.

If the analysis is attempting to address the likely long-term impacts (1990-2000), however, the information in the MFBI file may not be useful. (Twenty years is a long time, especially in light of changes in investment behavior which might come about due to the pending Capital Cost Recovery Act, allowing business firms to depreciate plants in 10 years and equipment in 5 years.) Changes in regional comparative advantages, demographic trends, and spatial market patterns, as well as regional constraints on pollution and rising energy prices, may dominate the importance of the initial conditions (i.e., detailed information on current boiler stock). In this case, a regional systems model is a more fruitful approach. Moreover, the uncertainties in our projections of the long-term factors of population movements and changes in comparative advantage could well outweigh any gain of having an accurate picture of the locations of boilers in 1974. For long-term impacts, it would seem more useful to project basic economic activity and estimate fuel and boiler configurations.

It is crucially important to define which issues can be addressed by an integrated regional model, and what tools should be used for short-term impact studies. It is unlikely that it is feasible to try to do both in the same framework or system of modules. However, primary information might be shared between different analytic approaches. It should also be noted that the current SEAS projections (1985-2000) seem to straddle the divide between the short and long term.

I will not discuss the last question raised above but stress that this is the question that the assembled modelers should be able to address and provide guidance to EPA in establishing a development strategy for improving SEAS regional capabilities. Considering the statement of goals and limited resources available, articulated in Paul Schwengels' opening paragraphs, the issue which should realistically be considered is how, in the intermediate term, can SEAS be restructured so that one of the existing or developing regional systems models may be used as a component module? Especially important for the conference is to articulate what would be the strengths and weaknesses of incorporating any regional models, and what questions might usefully be addressed with this extended SEAS framework. Clearly, the time and resources available prohibit the development of an "ideal" integrated model which could address all the relevant and important policy issues.

The available resources should be sufficient to set in motion a development strategy which could yield consistent, continued improvements over a longer time horizon.

REFERENCES

1. Focused is a strong word. In the actual arena of debate, the field has shifted from general methodological arguments to very detailed items, e.g., whether or not SEAS keeps its electric utility file updated to reflect new information on announced plant postponements or cancellations. The nature of the issues also vary by sector or module. It has been my feeling that, at times, the participants in the debate (on both sides) are sometimes confused about the issues as well. Much of the problem may be that it is hard to focus on what the real concerns are.

2. A partial bibliography of the current Regional Systems Models:

   A: Harris' Multiregional, Multi-Industry Model-operational at BEA and county level

      (1) Harris, Curtis C., Jr., *The Urban Economies, 1985: A Multiregional, Multi-Industry Forecasting Model*, Lexington Books (D. C. Heath), Lexington, Massachusetts, 1973.

      (2) ______________________, "New Developments and Extensions of the Multiregional and Multi-Industry Forecasting Model," presented at the 25th North American Meetings of the Regional Science Association, Chicago, Illinois, November 1978.

   B: MULTIREGION Operational-Primary forecast at BEA level
   Basic Reference: ORNL has developed a county skirt.
   Olsen, R. J., et al., *MULTIREGION: A Simulation-Forecasting Model of BEA Economic Area Population and Employment*, Oak Ridge National Laboratory, Oak Ridge, Tennessee, 1977.
   Since Dick Olsen left ORNL to join Charles Rivers Associates, two versions of the model have evolved: Dick has made several changes to his version and the ORNL Regional Economics Group has similarly made several modifications. We will be documenting the modifications in the near future.

   C: The BEA State Model Operational projections at the state level

      (1) Ballard, Kenneth P., and Wendling, Robert M., "The National-Regional Impact Evaluation System: A Spatial Model of U.S. Economic and Demographic Activity," presented at the 25th North American Meetings of the Regional Science Association, Chicago, Illinois, November 1978.

(2) ____________________, Glickman, N.J., and Wendling, R. M., "Using a Multiregional Model to Measure the Social Impacts of Federal Policies," in the *Urban Impacts of Federal Policies*, N. J. Glickman (ed.), 1979.

(3) ____________________, Gustely, R. D., and Wendling, R.M., *The National-Regional Impact Evaluation System: Structure, Performance, and Application of a Bottoms-Up Interregional Econometric Model*, Bureau of Economic Analysis, Washington D.C. (forthcoming - 1979).

(4) ____________________, Glickman, N. J., and Gustely, R. D., "A Bottoms-up Multiregional Modeling: NRIES," paper presented at Conference on Modeling the Multiregion Economic System, Pennsylvania, June 1979.

D: BEA/OBERS Projections Program (non-model approach) — Operational-Multicounty area BEA, States, AQCR, and WSA

Johnson, Kenneth P., "The BEA Regional Projections: An Overview," presented at the Southern Regional Science Association meetings, Nashville, Tennessee, April 1979.

E: Wharton — Operational - State Aggregates Census Regions

Milne, Williams J., Norman J. Glickman, and F. Gerard Adams, "A Framework for Analyzing Regional Decline: A Multiregion Econometric Model of the United States," presented at the Regional Science Association meetings, Chicago, 1978 (Discussion Paper #398, University of Pennsylvania, Pennsylvania, 1978).

F: Treyz/Regional Science Research Institute — (under construction) State level model

(1) Treyz, George, "Design of a Multiregion Policy Analysis Model," presented at the Twenty-fifth North American Meetings of the Regional Science Association, Chicago, November 1978.

(2) Treyz, George, Benjamin H. Stevens and David Ehrlich, *An Eclectic Core Model for State Policy Analysis and Forecasting, Handbook Three of Regional Economic Analysis for Transportation Planning*, Regional Science Research Institute, March 1979.

(3) Treyz, George, Benjamin H. Stevens, "Location Analysis for Multiregional Modeling," presented at Modeling the Multiregion Economic System: Prospects for the Eighties, Chestnut Hill, Pennsylvania, June 1979.

(4) Treyz, George, Ann F. Friedlaender and Benjamin H. Stevens, "The Employment Sector of a Regional Policy Simulation Model," RSRI Discussion Paper Series No. 107, Regional Science Research Institute, November 1978.

(5) Treyz, George, Benjamin H. Stevens and Karen R. Polenski, "Converting Regional and Multiregional Trade Coefficients into Endogenous Variables," paper presented at the Seventh International Conference on Input-Output Techniques, Innsbruck, Austria, April 1979.

G: Lakshmanan's Model (Under construction) BEA area projections

(1) Lakshmanan, T.R., and Fu Chen Lo, "A Regional Econometric Model for the Assessment of Effects of Air Pollution Abatement," Volume 4, 1972.

(2) Lakshmanan, T.R., Fu Chen Lo, and Drishra Mourthi, The OAP Regional Econometric Model: A Revised Version, prepared for Environmental Protection Agency by Consard, NTIS publication, Pittsburgh, Pennsylvania, September 1972.

(3) Lakshmanan, T.R., "A Multiregional Multi-Industry Policy Model," paper presented at Northeast Regional Science Association, May 1979.

H: READ Model County projections

(1) Donnelly, William, Arthur M. Haenner, B.D. Hong, Frank E. Hopkins and Terry H. Morlan, Estimating A Comprehensive County-Level Forecasting Model of the United States EAAD (unpublished).

(2) Donnelly, William and James N. Morgan, "Developing the Economic and Demographic Linkages in a Multi-Regional Econometric Model," paper presented at the Western Economic Association Meetings, Hawaii, June 1978.

(3) Donnelly, William and Frank E. Hopkins, "The Regional Energy Activity and Demographic Model," Northeast Regional Science Review, Volume 6, Fall 1976.

3. Harris has both a BEA and county version of his model. ORNL has developed a "skirt" for the core MULTIREGION model which allocates the BEA projections to counties retaining the same population and employment detail of MULTIREGION. The county model has not been fully documented, but is briefly described in:

   Vogt, David P. and Patricia L. Rice, "REBS: A Methodology for Addressing the Regional Implications of National Energy Scenarios," presented at the Northeast Regional Science Association, Baltimore, Maryland, May 1978.

4. INFORUM is used as the National Input/Output (I/O) driver for the SEAS system. The basic reference is:

   Almon, Clopper, Jr., Margaret B. Buckler, Lawrence M. Horwitz, and Thomas C. Reinbold, *1985: Interindustry Forecasts of the American Economy*.

   Almon has continued to update and improve the model at Maryland. It is not clear what version of the INFORUM model is currently in SEAS.

5. A significant effort is now underway on the part of MITRE to provide the requisite documentation.

6. Coates, Joseph, "The Role of Formal Models in Technology Assessment," *Technology Forecasting and Social Change*, Volume 9, pp. 139-190, American Elsevier Publishing Co., Inc., New York, 1976.

7. Ibid.

8. Ibid. The figure is reproduced from Coates' article, p. 150.

9. Documentation of the siting modules has been provided by MITRE in the background volume for the workshop.

10. SEAS, handouts.

11. DOE/OTI's Regional Integrated Impact Assessment Program (RIIA) has conducted several detailed regional assessments using the SEAS system. The national laboratory system (including ORNL) has participated with DOE for these assessments.

12. Adoption of several potential alternative technologies, such as solar and mass transit, could involve significant spatial reorganization over time. One of the current debates focused around solar technologies is the centralization - decentralization issue of power generation. A possible implication of decentralized solar generation is a decentralization of population patterns. Such possibilities are difficult to model and project.

13. For example, SEAS uses the recently released state level OBERS projections in one part of the model (IFUM) and the original OBERS (1972) projections in other parts. Perhaps more problemmatic is SEAS use of the two-digit OBERS earnings growth rates to project out the EIS detailed date base on value added in the residual sharedown. Other problems of consistency have been addressed in:

    Lakshmanan, T.R., Peter Kroll, Bill Barron, Lota Chattagee, and M. Pappas, "The SEAS Region Model: An Assessment of Current Status and Prospects," prepared for the Office of Research and Development, U.S. Environmental Protection Agency, Washington, D.C.

14. The Major Fuel Burning Installation File (MFBI) has detailed information on fuel boilers by individual plants identified by county (actually zip code ORNL, has prepared identifiers for its version of the file) and four-digit SIC code. However, the MFBI file is classified as confidential and, therefore, the basic information is not available for general examination.

15. ORNL has prepared several estimated state and BEA energy consumption and supply data series using the REBS system:

    Vogt, David P., Patricia L. Rice, and V. Pai, _Energy Availabilities for State and Local Development_.

        Volume I: Methodological and Data Overview
        Volumes II-IV: 1972-1974 Data Volume
        Volume V: 1980 and 1985 Projections

    Our experience with the poor quality of substate energy data and methods to develop adequate series has led to several research projects to improve estimation of the substate energy consumption series. One of these is reported in:

    Vogt, David P., "A Framework for the Analysis of Regional Energy Consumption," presented at the Eastern Economic Association Meetings, Boston, Massachusetts, May 1979.

16. Midterm Energy Forecasting System (MEFS) is the present version of the DOE energy modeling program which started as Project Independence Evaluation System (PIES). Most recently, DOE/OTI have used the FOSSIL II Model as the controlling energy model.

17. Of particular concern is that the Energy Modules for the industrial sector is not linked to the residual allocation program for nonfuel pollution.

18. For example, ORNL's Resource Analysis Group has error checked and updated the Generating Unit Reference File (GURF) and provided it to DOE/SEAS. More generally, ORNL's Data Analysis Group is conducting a large-scale data validation effort for DOE.

19. Weygendt, William, "The Coal Mining Module in SEAS: Description and Documentation of Methodology," CONSAD Research Corporation, July 1979. This document is contained in the Workshop Background volume.

20. This particular example was chosen because of ORNL's similar work in projecting fuel consumption. The approach we have used in the REBS model is somewhat different than used in the IFUM Module, and is described in "REBS," op. cit.

21. The SEAS Module IFUM (contained in the Workshop Background volume), of course, discusses the whole range of complexities involved. My simplification of the issues is done with apologies to the authors of the IFUM volume. The issues of projecting fuel choice in the industrial sector is a most difficult one to model in an adequate way.

22. Sedlik, Barry, "Regionalization Aspects of the Industrial Boiler Model," memo to Paul Schwengels contained in workshop materials.

23. The table indicates the number of large energy-consuming manufacturing plants. Plants using more than 3,000 trillion joules per year of fossil fuels are considered large energy users. The estimates were based on using the national average energy consumed per worker of each 4-digit SIC (Annual Survey of Manufacturers, 1975 data) and applying these coefficients to the employment data contained in the county Business Patterns file. Employment estimates are based on using the midpoint for employee size classification. Although this provides a rough estimate, it suggests that, when one looks at data at the detailed 4-digit level, a different picture emerges than when considering 2-digit aggregates. For example, only 452 plants in the stone, clay, and glass industry (4 percent of total plants in the

industry) are estimated to account for 77 percent of the energy consumption. In the tobacco industry, generally not considered energy-intensive, we find 11 plants which may be considered large energy users, presumably because they are large-scale operations and not especially energy-intensive. This table is part of research conducted at ORNL in support of a study to investigate the potential coal gasification (low Btu) penetration. The study was done for DOE/OTI.

24. A pilot study is underway in the Regional Economics Group to investigate one industry (stone, clay, and glass) in detail. The purpose is to see if we can separate the 4-digit subsectors into market versus resource (including energy) orientation and estimate the energy requirements of each class.

25. Ballard, Glickman, and Gustely, op. cit.

26. An ORNL study using the MULTIREGION/REBS modeling system was conducted for DOE/P&E and is described in:

    Bjornstad, D.J., and D.P. Vogt, "Regional Economics and Energy Consumption Implications of the NEP-2 Base Case Scenario" (ORNL/TM - in press), May 1979.

III. TRANSCRIPTION OF SUMMARY SESSION

This section contains the edited transcription of the summary session, during which the rapporteurs for the groups reported the results of the groups' working sessions. The transcription follows.

Lowell Smith: I think sometimes at meetings like this, more good comes out of the private conversations than out of formal discussions, so I almost hate to stop your private conversations, but we do have to get on with the business of the day. The remaining business of the day is to hear the report from each of the individual discussion groups, with the modification that since groups 3 and 4 have combined we'll have a merged report from those two groups. Peter Hall will be giving the report for group 1. Then Brad Perry will be giving the report for group 2, and David Vogt will be reporting for groups 3 and 4. Any additions that Dave did not pick up on the first day's discussion in the group he was not in will be filled in by Dick Ball. I think after each rapporteur gives his summary of that group's activities, we should ask for discussion of two kinds: any additional points by members of that group and general discussions on findings or recommendations or whatever has been reported. So, that means we have 9 items, 3 times 3, following which we will have two responses, one by Haven Whiteside from our Strategic Analysis Group to give a user's response to what he has heard, and a second will be in terms of what a modeler would recommend as the next steps that the SEAS family should consider undertaking.

Paul Schwengels: We are tape recording the whole session this afternoon, so please speak up. We would like to get some sense of what the comments are after each presentation. Also if presenters have any notes in outline form we would like a copy as it would help us interpret what's on the tape. So let's start off with the agenda with Peter Hall first.

Peter Hall: Unlike the other two groups, we were so successful in resolving all of these issues that we started working on SALT 3 at 9:30. So we're in good shape. Actually, I'm not sure what's going to come out of the other two groups but I think that in retrospect the design of the questions that were given to the groups was probably naive, given, and that's in retrospect, the difficulty of the issues that we're trying to look at here. After a day of trying to discuss a framework for discussing the questions, we came up with four major findings and I've added two recurring issues which I'll also talk briefly about, not necessarily in order of importance.

One thing that came up is that we would really like to see EPA do something that DOE apparently is doing right now, I think, with Oak Ridge National Laboratory. That is to get the users of SEAS in the Agency to formally articulate the policy issues they would like SEAS to analyze or see SEAS being of use in analyzing. Once these policy issues are articulated then I think that it'd be much easier for SEAS developers and operators to respond concerning what it is presently feasible for SEAS to do, or with model development, what model improvements would be necessary, and what questions aren't feasible at all. We don't have to restrict that necessarily to regionalization. One thing that this might do is make everybody's expectations of SEAS a little more realistic in the future, and we can perhaps consolidate our design efforts and development efforts into something a little bit more rational than what is occurring right now.

The second point is that we obtained a consensus for adopting a conceptual design similar to Dave Vogt's design, presented yesterday, for improving the regionalization methodology. The design can be summarized by noting that, first of all, it maintains the modular structure of SEAS as far as the regionalization is concerned, with special modules for environmentally important industries containing more substantive regional information. The SEAS region module should have the flexibility for incorporating alternative perspectives such as expert opinion or other nonmodeling sources of information at any given time depending upon what the use of the model is to be.

Complementing this should be a policy-sensitive, multiregional economic model which interacts with the special sectors and provides a more behaviorally oriented framework for other industrial sectors than does the current region module.

Now in conjunction with this recommendation we should undergo an in-depth review of currently existing multiregional models, and this review should not only look at their relative structure pertaining to geographic detail but should also specifically address the integration problems which are likely to be associated with each model. This review should also include looking at the potential for developing a regional model from scratch. And also we should decide whether it's actually cost-effective to include regional models. This review, because of the need to look at funding considerations, should probably be conducted by contractors or people associated with EPA and DOE but should be assessed at least in draft stages by all participants in this workshop if they're willing to do so.

A fourth point is simply that an independent, and I stress the word independent, review of SEAS should be undertaken which should consider the whole model. This should definitely follow on the SAB review that was conducted a few years ago and build upon that base.

One recurring issue that popped up all the time in our group was that the major problem anticipated in doing any development of regionalization is integration. An example is the problem of integrating the sectorial information that you would get from all your different components of SEAS into something that is compatible with the RESGEN module which generates the environmental forecasts. For example, if we developed data at the BEA level, we would want to make sure that it was reasonably consistent with the national level.

The second issue is: "What is the appropriate level of regional detail?" All that we could come up with on that was that the appropriate regional level detail is going to differ according to the theoretical and empirical perspectives of the individual or problem. A model which incorporates well-defined behavorial characteristics can only be carried to a certain regional level given the limitations of models and data. We're definitely going to need forecasts from SEAS which are extremely disaggregated but we should at least explicitly acknowledge for each application the level to which we can legitimately forecast, or trace back a behavioral base. Then, if the user wants to go down to a lower level, it's going to be a more simple-minded sharing methodology. This needs to be made explicit so that the user knows what he's buying.

Those are the issues and the summary points exclusive of SALT 3.

Lowell Smith: Are there other additional comments from other members of the first Work Group?

Paul Schwengels: I'd like to mention a couple of recommendations made by Frank Giarratani since he was unable to stay for this session. Frank's perspective is defined by his interest in the relationship between economic theory and modeling. He expressed a strong feeling that the projection of regional activity of all economic sectors in all regions can't be just done in any theoretically justified, valid manner and that all we're achieving with such models is a rough approximation or a systematic guess. He initiated the recommendation that we have an outside review and I think that he was specifically concerned with a review of the economics in SEAS by someone outside of SEAS. The review would make explicit where we have economic projections that can be traced back to some theoretical structure, how far we can go in that manner and where we jump off into something that is less rigorous. That information should then be referenced in any subsequent SEAS reports. The related item Frank emphasized was that theoretically sound projections could be made down to a certain fairly aggregated level for those sectors of sufficient interest for which data was available. He suggested that we try to do that and integrate it back in some way into the regional model. He is currently doing work himself in trying to statistically demonstrate or determine what regional group or industrial groupings exist. For example, he uses the steel industry as a leader of a certain definite grouping. If we were willing to spend the effort to seek some detailed regionalization in the iron and steel industry we could probably obtain some information about five or six related industries. He recommended we consider that approach as a way of getting some regional information about a number of industries.

Lowell Smith: That suggests that one might be able to do cluster analysis of industries in general and really focus regionalization on clusters and not on individual industries.

Paul Schwengels: Or focus on a dominant industry leader for each cluster.

Lowell Smith: Yes?

Martin Duffy: My feeling is that the first point, the one about the articulation of views, should precede any of the other kinds of action taken on regionalization of information.

The experience I've had with regional modeling tells me that what you'd like to do is find the simplest workable model that gives you the information that you need to carry out a particular kind of analysis, and to have someone to hold accountable if things don't go well. But what I would like to see personally from the policy side is a model that works, a model that is presentable despite its limitations and one that can be built upon and one that's going to be there five years from now.

Lowell Smith: O.K. Are there other comments on the report? Or reactions to it? If not, let's go on to the next report.

Brad Perry: We developed a set of recommendations, which I'll just read to you. The first one was to run at a more aggregate level, to run the system or redevelop the system at a more aggregate level both geographically and in sectoral detail. Geographically, we were all agreed that countries were not appropriate for any kind of economic model. At the same time we recognize that EPA probably needs some kind of county sharing approach which DOE may or may not need. Art Katz at DOE suggested that national laboratories could handle further regionalization outside the model. On the sectoral detail, to clear up inconsistencies that Nazir referred to both yesterday and in his paper, we propose that the product process detail be developed at a regional level and we traced out for ourselves how this could be done with the existing data in the model. For instance, instead of doing it at the national level and sharing outputs, products and processes down, share products and processes at the regional level and add up if you want totals. O.K.; that's basically our first recommendation.

The second one is to use the latest data, and the example we discussed was developing the baseline from the '77 census of manufacturers and abandoning the '71 employment data.

Third, and this begins to sound very much like group 1, review the existing, regularly produced regional forecasts to replace OBERS. This review should look at methods, linkages and success in capturing secondary impacts, which are a concern that's been expressed all along. Rather than replace what's in SEAS with a brand new model, we see the possibility of using some forecast in a sharing method, at least a backup, and I think we all agreed that it was better or no worse than nothing at all. We clearly recognize the cost in producing regional detail and the lack of substantial economic theory and data underpinning of any of the procedures. The system should be designed so that the regional part of the model can be run in only as much detail as viewed sufficient in each case.

Our fourth recommendation concerns separating out uniquely located industries. For example there are presently six primary zinc smelters, and obviously adding the seventh does not make sense with any kind of regional model. Apparently that 6 dropped down from 12 or 10 a few years ago. We outlined a number of such industries - primary smelters, petroleum refineries, and the examples go on. We felt that it would probably not be very difficult to separate these unique industries out of the INFORUM projections which are being regionalized, but then add back in the employment and so forth at the regional level. Clearly that integration has to take place and a first cut is just doing a fairly straightforward subtraction at the national level from the core of SEAS and adding it back in at the regional level. Clearly one could go from primary smelting to petroleum to pulp and paper and by the time you're finished you may have uniquely located practically all the major polluting industries. At that point you really don't need a very sophisticated regional model in SEAS. We discussed this unique location being done with a file generated by expert opinion going into the model at some point. I think the point we recognized yesterday is that the regional model cannot locate an oil refinery in Smithfield, Virginia. In other words an oil refinery on the east coast is going to be an event that takes place within a six year span and there is no point in using a regional model like this to project that.

Five, we thought there should be a study of the implications of the prespecified parts of the national scenario. The example that was discussed is energy-superimposing an energy scenario on top of SEAS. Clearly this causes inconsistencies and the study should determine how serious these inconsistencies are. This I guess gets back to the recommendation of group 1 of interaction with SEAS users.

The way I've written out our final recommendation really doesn't capture it. It's really a class of recommendations for making SEAS more streamlined and more useful, and to make it easy for SEAS to accept alternate regional scenarios. As I've stated, we did not recommend right away, or perhaps at any time, building a regional model within SEAS. However, if we want to do a sunbelt-snow belt scenario, or we want to do a decentralization of employment in industry scenario, clearly you need a fairly sophisticated regional model linked into SEAS. The other example that comes to mind was the Ohio River basin study. The information in SEAS can be used not only at the national level but also at the regional level for a regional study. There are sort of two approaches to this: 1) the river basin study would provide all of the regional economic data and SEAS would just provide the pollutants, 2) the river basin or regional study might only provide key economic data. In that case, the regionalization of SEAS would be used to provide the backup economics and would be the fall back position as far as forecasting the regional impacts.

Lowell Smith: Thank you Brad. Are there comments....

Comment: There is some question which sections you can leave in and which sections you can leave out, but there's no question in general that a prioritization could be made. A good deal of SEAS could be picked up several levels of detail without any loss to the accuracy of the environmental projection and at a gain to the accuracy of the regional economic projections. The question, or task that remains for whoever improves the model is to delineate the number of sectors that have to be dealt with separately. So we are still arguing for, if anything, increasing the modularization of the regional process, taking those industries that are critical and viewing them separately either with expert judgement or like in the case of utilities with a set of algorithms that are in the model.

Lowell Smith: That might be a very useful recommendation in that clearly SEAS is a very cumbersome system to operate now, and to increase the complexity of the regionalization and get it right almost means something has to be pruned away. It's about time to start making some of those decisions as to what we need or what we want. I think we agree your group report was very, very useful, Brad.

The discussion which followed was not recorded completely but can be summarized briefly. The comments by several participants addressed the appropriateness of "band-aid" versus "major surgery" approaches or some combination of the two. One commentor went so far as to suggest a "head transplant."

Lowell Smith: O.K., I think it's clear that we do have a consensus that we best make the improvements that we can make easily that will result in a cleaner system regardless of our long-range strategy. As has been suggested, we need to do it instead of talk about it.

Lowell Smith: O.K., with that helpful comment, we'll go on to groups 3 and 4;...David....

David Vogt: ....I think my joint report for Groups 3 and 4 will show the classic symptoms of merge-files. We started with two separate sections which were combined the second day. One issue that came up in both sessions was that model requirements should realistically be viewed as a long-run projection tool and one needs to explicitly state the limits and range of uses for which you could use such a tool.

The second thing that came out strongly (in Group 4) was that the current model using OBERS is not appropriate and a small-scale fix-up would not be advisable and this suggests against an incremental approach.

Our group spent some time discussing the elements of an alternative modeling framework and in terms of a regional unit, it was felt that some large spatial aggregate such as a state or BEA area was appropriate for projecting core economic and energy variables as a starting point. The top-down approach seemed adequate for long-term analysis. Ken Ballard specifically commented that his bottoms-up model is considered to have clear-cut advantages over top-down approaches only for short-run projections.

The other issue was that, rather than a separate module, the regional model should be seen as a core component and in the central framework of the overall model.

Another strong feeling was that we should incorporate more behavioral relationships when we can in both the regionalization and the sectoral modules.

Where more geographic detail was needed, we felt that a two-step approach should be used: first to regionalize to the state or BEA level using the full regional model and then use a simpler shift/share approach to go down to counties. Here a whole range of possibilities open up. For example, if you forecast certain activities for the Los Angeles area, you might then use a shift/share approach specific just to the Los Angeles area for more spatial detail. You might have a different shift/share model for each BEA.

Also in the discussion of sectoral modules, again we suggested that certain industries would need to be selected out to be regionalized by side studies (or modules) using industry experts, location analysis models or other longer-term analysis. The problem there is in breaking up process/product, etc. There are always going to be some inconsistencies between components which should be minimized to the extent possible. They are always going to be there, but we should make them explicit and indicate what types of problems they might present to the interpretation of projections.

The first day we decided that the issues of the availability of data shouldn't even be addressed (by the workshop). Models and what data you use should be handled by the research team or contractors. One general comment: regional data indeed presents a constraint on any regional model. There was another strong feeling that what regional data does exist - let me rephrase that -- there is more regional data out there which can be obtained in more creative ways than have been used in the past.

The last issue we talked about on the first day was the interaction with other regional users of SEAS. Our feeling was that any formal new model should really just provide core baseline projections that you could provide to regional analysts to do side studies which might modify outputs from SEAS. To do this appropriately, you have to have adequate documentation of SEAS and make the appropriate linkages explicit. We shouldn't attempt to have such side studies provide feedbacks to the overall system as this presents too many problems.

The second day when we merged the two groups, it became clear that one group (Group 4) was concerned about long-term development strategy but that something needs to be done in the short-term (emphasized by Group 3). The thing that came out overwhelmingly in the joint session was that we need two strategies: first, a long-term development to start with a design phase (what the model should do and so forth) and then going on to implement the new design; and, secondly, a short term strategy to make what is now there more usable and explicit to the users. The remaining suggestions deal with short-term improvements.

Clearly, documentation is needed. There are a number of types of documentation needed. The first category was the general overview of the current systems and models and the important linkages between the modules.

The second type was the data base documentation. Where does the data come from? How is it modified? What is the rationale for the particular data series? and so forth. As a short-term improvement to the base data, it was suggested that independent industry surveys or other supplemental sources might be incorporated in an override file. There are some opportunities there, but rather than just putting data into a share file, the information behind the files might be useful to the user to help evaluate which sectors are being handled by which methods. The user should be given the information necessary to evaluate the data files in a consistent way.

A third area where we thought some short term gains could be made were in the base-year data. It is possible, by examining the several different data series that are available, that we might synthesize a more consistent set of data across several variables. Also just getting a strong feeling about the reliability of base data would be useful.

The last area which was brought up was that in many instances users could use intermediate results, not just the final, and so some method should be developed to produce those results in a format that would be intelligible to users.

Lowell Smith: Thank you, Dave, for a fine report. Are there other people in groups 3 and 4 who want to add to Dave's report?

Carol Metzger: Only one thing that Dave omitted and that was the concept of reporting the confidence you have in the data so that users get some measure of how good the data is.

Lowell Smith: Other comments? O.K., if not, I want to thank each of the group's rapporteurs and discussion leaders. I think, contrary to what David said, there is not only overlap but also a great deal of augmentation that each group gave us and I wonder what would have happened if we'd had five or six groups instead of 3-1/2. Rather than speculate on that, though, I would like to encourage each of you who care to, to write down over the next week's time any additional ideas about what EPA and DOE should do to address the problems that we've been attacking these two days. Address those to both Dick Ball and myself and hopefully he and I will keep in close touch with each other. I would strongly invite you to if you have the urge to do so because I think that after you've had a little time to cogitate on the discussions of these two days, things might clarify in your mind more than they have this afternoon.

Next we should proceed to hearing from Haven Whiteside who is second in command in the Strategic Analysis Group at EPA. Haven will give us his reactions to the workshop as one of those potential users of SEAS -- he'll be a user of SEAS sometime in the future.

Haven Whiteside: I couldn't decide from the introduction whether I was a user, or a historical user or a potential user: a potential user is at least part of the truth. One recurring item was the plea that EPA ought to clarify what it is that we want SEAS for in the first place -- and Peter you made that as your first point -- and that's an awfully good idea. I think it would help us and obviously it would help you. Often it is not possible to do because applications of the model develop after we see what it can do. We awaited with great interest the trends projections we got from SEAS last spring. Until we got them we didn't know really what we were going to do with them, because we didn't know what they were going to look like. And after we saw them, we spent a lot of time with the contractors and subcontractors talking about how we wished they would be this way and what did that mean and a lot of things but the fact is that this is a learning process. So we will try and do our part in an iterative manner by saying what it is we want to do with them. This year our basic mission in strategic analysis is to identify future problems, and I always like to tack on the word opportunities, and you might even add on the word accomplishments because one of the things that we don't really have right now is a sense of history. When we talk to people they want historical trends as well as future trends. We found that when we went in to some areas SEAS doesn't touch that all we could show was historical trends that we got from some other source. That was useful and said something. Also we find that EPA is in the throes of a great review of the way data is handled so that there may be better historical data available. It will reflect ten years of experience of taking data and may be enough of a base. I was talking to a fellow today from one of the states who wants to establish a report card for his state, at the request, incidentally, of his legislature. So, okay, I suppose you'd narrow that to environmental issues. Could you have an environmental report card. You know there isn't very much in the way of that around -- I know of one, not a government one, but that kind of thing would be helpful -- it would describe to us what is happening to some extent. With that as a context, where does SEAS fit in? Do we use it for national trends or do we take the regional trends? Sometimes we have these maps that show subregional sources of this or that. To the extent that those are valid, those are just fine: they're very nice. The discussion here has been in part centered on the fact that many of those are not valid -- particularly the more you disaggregate, the more you lose validity. And so I would say this -- we don't really need to go down to very small subdivisions in a comprehensive manner. We do need to do national projections, we do probably need to do regional projections in the order of magnitude of the Federal Region. Beyond that it may well be that what we need to do is some samples. Take Chicago and see what's going on there. Or take a particular river basin and see what's going on there -- or an estuary -- or a localized thing. The reason I say that is the biggest gap we have to face in SEAS is the fact that there is no impact analysis of any kind. The questions that the agency really has to deal with are questions of what's going on in the environment, what is it doing to ecology, what is it doing to ecosystems, what is it doing to personal property. All of these ultimately are questions that science can deal with only on a small scale. If you get down to the size of one city, you've still got a pretty large aggregate, there's still a lot of variability that you're going to have to deal with. For example, somebody mentioned a smelter. If you place it anywhere near a city then you've got the impact on people. If you place it out in the country, you've got the impact on fewer people, but then you've got the impact on national parks and some of the other things. Since Jack White isn't here, I can bring up the Western Energy Study ordinarily I avoid it. One of the really nice things about the Western Energy Study is that they took the six sample locations and said: "Suppose we build a coal gasification plant here, what would happen?" And that to me seemed like a useful way to get down to very small subregional levels because then you can bring questions like: What about the transportation? What about the people that come to build it, and all the other things that go on to high level of detail that you never get if you start at the national and work your way down. And then I started to wonder out loud if whether having done that -- whether it be a gasification facility or whether it be a radioactive storage facility or whatever -- you can with your national model say we're going to need 12 of these results by the year 2000 and they will be around at least in this area of the country and then not worry about siting in more detail because there are just too many unknowns. The thing that is important to get across is that the people in that area of the country are going to have to think about siting those. Backing up again to the national scale would be the message that it's going to be sited someplace and, therefore, EPA research better get busy and see what the effects are of this type of facility as opposed to some other type that the projections might show were not going to have increased and, therefore, would be less important to address.

So that's a general view of what we'd like to get. I'd like to mention a few of the more general comments about SEAS. I guess the last one is really the most important that occurred. Basically, it really would be better for SEAS to do less and do it in a way that we could all in this room be very confident that it does it right. We're always complaining we'd like SEAS to do more but our real Achilles' heel is that if it does something at this point and we are not confident of the results, then it is virtually useless.

At any rate, we're prepared to spend a significant amount of our resources in defining what SEAS can do and in ensuring that it is done right. We think it's of exceedingly high importance. Having done that and maybe in the process of doing that, we have other objectives.

One of them would be some sort of way to interact with the model and ask questions such as how it got this or why that is happening and be able to trace it through. That would be useful for policy analysis, and it would be useful for validations. It would be useful for convincing people of your intent especially if it includes results -- I think that would be very, very important. With that capability will go a temptation at least for people like us to spend a good deal of time interacting with the model. Of course that's time and money and, therefore, if there's any way to have runs that don't bring in the full baggage and that can be shorter, and sweeter, that's going to facilitate a lot of things. That would also allow us to do more sensitivity analysis. One of the things we tried to do this year in our environmental outlook report is a cross-cutting chapter on energy. That is to look at alternative energy scenarios and see what difference they might make by 2000. Take a high solar, take CEQ's scenario, high conservation, high synfuels, etc. We found out that the SEAS model as it was constituted at that time didn't really give us answers. It just wasn't set up to do that. It was too resource intensive, it would have taken too long. So we have to do that in another way. We would have preferred a sub-set of SEAS. We could have had someone go ahead and spend their two weeks or a month of running some things for comparative purposes not to get absolute numbers but rather to say how are these things different from one another. And I don't know how you get from SEAS to that, that's again something maybe a little more distant in the future.

I'll say one other thing since this is a regional workshop, you should know, you've probably heard it already, but I'll say again that the regional briefings which have been based upon environmental output, where it's done at least 50% to 60% by SEAS have been very well received. So that the idea of having a package that covers at least the federal regional level going from the national down to that level is one for which there is a market within EPA -- there's no question about it. There may be even more of a market for that than there is for the national level. You're almost in a vacuum where, at the national scene, there is competition from various sources. At least, going to that level -- which I assume is the easiest level to go -- it is probably something that's well worthwhile doing again. It's worthwhile building in the flexibility so you can talk about what's going to happen when all the energy comes from Colorado oil shale and, therefore, all the industries move there and move out of Houston. And then we get the sun-belt and get a mountainbelt phenomenon in the 23rd century or whatever other ideas people may want to come up with. Those probably could be dealt with at the federal regional level -- at least getting some insight. I am very interested in efforts to do some regionalization better in SEAS and encourage you to think of the larger region and perhaps one that would be particularly useful to us. Those are my reactions.

I must say that I found it an educational experience. I learned a lot about SEAS just by being here.

Lowell Smith: Any responses to Haven's comments?

David Vogt: I'd like to give you a bit of my experience with the bootleg small-area energy model that I operate. We run a multiregional model based on INFORUM which develops BEA area historical and projected energy series that provide a rough characterization for each region. Most of the people that use the data appropriately are doing selected detailed small area studies for either DOE or private subcontractors for local agencies because they do not have econometric models or reference point data. One of the pitches I've always made to various departments of DOE is to have something like our general system which would provide a consistent small-area projections series that would act as the baseline for small-area analysis. If one wanted to study the Ohio River Basin or regions in the West, regional analysts would then have a consistent starting point to do the (area) impacts (on population or various categories of employment). Without such a point, it is hard to analyze what all impacts are and what is going on in a region relative to the rest of the country. So, even if one is initially interested in only Federal Region trends, but later on may wish to look at selected areas in terms of detailed impacts, one would need to provide a baseline reference and some consistent view of the future for all small areas. Now that is not to say that everything one estimates at the regional level has to be constrained to those baseline projections, but the baseline series provides a starting point.

T.R. Lakshmanan: What you've said basically is that less is more. I'm feeling the same about SEAS. I see the logical extension of this doctrine in trying to collect everything at the federal regional level. But I would also suspect in view of the needs we've heard expressed, that some regional capability below the federal region would be useful.

I think we should be able to respond, but what is the appropriate regional unit?

Lowell Smith: Other responses to Haven's comments?

Peter Hall: My problem is a very simple one. I learned computing on an IBM System 20. You used to go in -- you'd open, key in. You'd use it and you'd come up with something. The first time you ran your program and finished your debugging, and it actually ran. Then you have to see whether it's right, and so you'd compare it with some hand calculations. And when something seemed strange, you'd trace it out and see what this algorithm does. I always have a mental image that you really ought to be able to understand all a model's workings, if you're going to use it. You really don't have to check it out everytime -- you have to check it out some of the time -- and so far I don't see quite that happening with SEAS. So with that purpose you need to be able to get in and do that -- you don't have to do that every day. You don't have to do that when you're doing other activities. What's going to be the difference if we go all solar or if we go all Libyan oil. That's a different thing which would require different kinds of output much more streamlined, much less detail, so you'd be operating a system with a different load. They would be incompatible if you tried to do both at once.

Comment: Admittedly, what Nazir says is true: there are segments that are so complex now with so many interactions, the utilities model being the best single example of that; there are 10-fold programs operating simultaneously. And few people in the system knew what all 10 or 12 did at the same time and so when they were trying to track it, they had to do it one piece at a time and go over each one separately because there was no clear flow-diagram to hold on to.

Nazir Dossani: The one suggestion that I have is that even though the system as a whole is very modular, that the individual modules could be a little more modular themselves; that a lot of things go on simultaneously, and that what's probably needed is some intermediate output that can trace, that can help you trace, very easily how you got the final output.

Better reports of intermediate results are needed showing all the relevant variables that are going into this thing; the coefficients that are coming out and what's being computed by the model. There are so many variables, that it's going to take a while to design all those printouts. You need to have the intermediate numbers and then you can say this is what the model has computed from all the data that I've put in through all the little separate plants.

Lowell Smith: O.K., other comments, reactions to Haven. Thank you very much, Haven. Hugh Pitcher is clean-up speaker this afternoon. He comes from our Office of Planning and Evaluation, which historically has always had an arm's length view of SEAS. And I think for what they and other parts of EPA would see as justifiable causes. However, Hugh is taking time out of his otherwise busy schedule to help us to go through a yearlong evaluation and cleanup of the SEAS system. I don't think we could have found a better person given both the history and relationship of OPE with ORD and what Hugh personally brings to this task in terms of his own experience and output. So I think we all look forward to the very wise counsel that Hugh will give us based on very good advice we've already received. I've asked Hugh to summarize for the workshop as a modeler, not as a user of SEAS, and to point out the most important thing to deal with in trying to improve its regional capabilities.

Hugh Pitcher: ....I've been oversold here.... Trying to summarize something like this is a little bit like trying to take a plate of spaghetti and know what the plate looks like, and take each strand and lay it out and see if it makes sense. I really can't do that. I'm sure what the plate of spaghetti looks like -- what makes for a quality model. You have that perception. If you've ever read Zen and the Art of Motorcycle Maintance, you'll understand what I mean by quality. Prior to all the analytical issues that result, you pick up a model and based on your experience you trust what comes out or you don't. We are stuck with the rather uncomfortable position of having a model where our initial reaction is not what we'd like, and the question is how did we get there -- the developmental issue, which is the other subject. Let me talk a little about quality and how that relates to the last few days. Now, quality to me in a model is something that is useful either because it informs the decision maker of policy in a general sense -- it is a good description -- or it is useful because I can use it for analytical purposes -- I can pose a question, I can do an impact analysis, I can do any of the many different kinds of things I need to do analytically and it's informative. By informative, that means if something strange happens, I know why it's there. I can go back and change something, and if I change it I either can understand why the model reacts in the way it does, or I can separate out what I think is the cause. Having that understanding involves two kinds of issues. One is the documentation, and I mean documentation not from the point of view of this is the module and this is what goes into it and this is what comes out of it. That puts me to sleep. Some part of that description has to tell me what's going on, what idea I had for doing it and how I'm doing it, what the concept is, what the ideas are, because you're going to have your problems. If you put the concepts down clearly, lay out what you're trying to do, modelers will disagree technically about what you did and will have lots of technical criticisms but they may well be able to say, at least you did a good job. I know what you're after so there's understanding and comprehension of what turned out. I guess the other part of documentation that's been attended to is data standards. What the data is, what the categories are, and what the standards are. Now EPA collects an awful lot of environmental information. It would be very nice if that kind of environmental information would get clearly into whatever set of environmental residuals we're looking at from the point of view of SEAS analysis -- whether it be a less sectoral detail model or a more sectoral detail model. We would have an agreement that the data that comes into this fits and makes sense. In that sense, SEAS is a very large effort -- it's much larger than the model we have here. It really is the data set that distinguishes this effort from any other large-scale modeling effort going on in the country. We have access, so it makes sense to key whatever we do, environmentally, off this kind of a data-base.

Then the use of the SEAS model? How do you take it apart from the point of view of understanding that it works the way you want to as opposed to how do you get the short and simple output from which to do sensitivity analysis. Maybe you have to make a compromise. Still you don't want to fill up four disk packs of data between those exercises which are designed to validate the model and those exercises which use the model.

The decision-making sensitivity of the model is another aspect of the quality. You've got a system out there that doesn't respond very well and isn't what they need, it may be good but it's irrelevant. Its irrelevance wastes limited resources. It's a fact of life in the bureaucracy like it is everyplace else. I think thinking about decisions and thinking about costs gives you a feel for what the things are that make a difference in the model. That's why you have to iterate. We do the best we can, we go ahead with something that works and see where we are and we do something else. But central to that development has to be the relation to what the needs are. Maybe it just needs form. Maybe what they need is a good trend analysis to come out that they can understand and know where it's coming from. Maybe just that information is a very simple thing. But then we've got lots of different alternatives. What are the alternatives? What do they look like in terms of economics, in terms of energy constraints on the economy, on the macro-economy? I see 3 percent of the GNP going out of the country to buy oil as being one of the largest single constraints on the macro policy in a decade. What kind of choices do we have? That is a good question.

So you get resources, you get direction into the model. You do the best work you can at any point in time. That's probably where the government has its biggest problem. I know I go crazy monitoring contracts. I don't know of any analyst who doesn't. It puts this very difficult interface in between the people that are doing the work and the people who are users and would rather be out there doing it. So let me leave aside this quality issue and talk about developmental issues. And let me just try and give the flavor of the picture that I've come to pick up.

Lowell invited me to be inconoclastic here and that's exactly what I'm going to be. My own reaction to what I've seen. I see two kinds of pieces. One is kind of a model that I think will probably be fairly aggregate, since it is much larger than the county and talks about background pollution related to general economics. And I see another model -- or another piece of the model, that reflects the large amount of detailed information that we have about large point-sources of power plants, economics and so on. The issue is really how to combine those things and combine them in a useful analytic framework with very high detail we have about the larger point-sources with the general level of economic activity determining the background level so that we can talk about the siting issue -- which may be very complex. I think siting is going to be -- for political reasons, pollution levels, and all these other kinds of consciousness -- a very difficult issue. We can talk about the impacts of this kind of a model on siting issues. Now that's a very detailed kind of analysis and yet if we have a BEA regional frame for the data sources I think that's a technical question that a technician ought to decide. I think we handled that question very successfully when I was at the Labor Department. We probably had 9 out of 10 of the top Labor economists in the country on our payroll in some fashion. If we wanted somebody to look at something, we sent them a paper and paid them $250 or $500. If we wanted to find out about something, we sent them a purchase contract for $10,000 and said write down what you know in 30 days. We are at, as I gather, the state-of-the-art and we ought to be able to interest good regional economists in an application-oriented, theoretical development after putting this thing together in some kind of good shape. You're not going to get good models without the very best people. Now, it takes a lot of other kinds of resources but design is obviously critical -- both here and to the issue of quality. Really critical. I think there are a lot of things that could be done in terms of structuring this model to make it fairly simple when you take apart the modules. I think that's critical. That's a model where you can take any one piece out, look at it, the linkages are pretty clear because they're largely one way, so you don't have this, you're not trying to solve large interactive models that we're not already solving in a routine fashion. I'd rather have a model that's maybe 95 percent of the state-of-the-art that works. We have policy meetings. We need something that works, not the best model in the world. We need to know what the best model looks like so we can be just a little behind the cutting edge. We don't want to be five years behind, but we don't want to be out there trying to write the model that hasn't been written yet, while we're doing the design. Obviously, the design paper is critical. The next piece is the development, trying to get rid of OBERS and going to some other form of generating local kinds of predictions, the local activity levels. Well, the local activity levels may be not too critical, the regional, the federal regional level, the state level if we're going to use this in terms of detail levels having a notion of what drives the local regional levels that we can justify.

I think one of the issues raised in our section is that you need a general model that you can override with specific information when it is appropriate, but when that specific information isn't there you've got a natural fall-back. You can put it in if you have it and if you don't have it, the model solves itself.

I probably said more than what makes sense. I've enjoyed it. I've learned a great deal. I'm not sure.

Lowell Smith: O.K., are there any responses to Hugh's comments? If not, I want to thank each of you for participating and thank you for your comments, Hugh. I would suggest the workshop really isn't over though, until each of you, who can do so, responds to us on a personal basis. I'll be looking forward to hearing from you and I'm sure that Dick will too. Thank you each for your participation.

IV Summary and Discussion of Workshop Recommendations

1.0 INTRODUCTION

This chapter summarizes the recommendations made by participants at the Regional Economic Modeling Workshop. An attempt is made to identify recurring themes from papers and group discussion as well as areas where differing points of view emerged. The chapter is organized into five sections. The next section discusses recommendations of a general nature as they relate to SEAS objectives and applications. The following section (3.0) reviews specific comments regarding regionalization methods, including questions of industry and regional detail. Section 4.0 provides a summary of the discussion related to data base development, model documentation and validation. The final section provides some concluding remarks.

2.0 GENERAL OBJECTIVES

There was a broad consensus that SEAS needs to be simplified--in structure, in operation, in ease of access to its data, and in the way information is communicated to the user. While there was general agreement on this point, the views expressed varied in degree and approach. Despite agreement on this objective it was recognized, particularly by SEAS analysts, that there are continual demands on SEAS to be used in a broader range of applications. For example, SEAS has been used in such differing applications as:

- Assessing the impacts of the Federal Water Pollution Control Act Amendments (PL92-500);
- Providing the analytical framework for the Cost of Clean Environment Report to Congress;
- Assessing the environmental trends implied by

the National Energy Plan II;

- Technology Assessment of Solar Energy;
- Regional Issue Identification Assessment;
- Annual Environmental Analysis Assessment Reports;
- EPA Integrated Technology Assessments; and
- EPA's Environmental Outlook.

There are clearly some tradeoffs in simplication. A simpler model would be able to provide answers in a shorter period of time. It would also be more amenable to sensitivity analysis. But it could restrict the ability to analyze the wide range of tradeoffs between economic, energy and environmental activity and the level of detail at which analysis could be done. The workshop participants seemed to agree, however, that with some careful planning the model's complexity could be reduce without sacrificing other desired attributes.

A formal articulation of the policy issues SEAS users would like the model to address could assist in giving direction to this task. One of the SEAS analysts, however, felt that many users did not really know how to best apply SEAS capabilities until they had a chance to work with them. Moreover, the focus of applications would undoubtedly change over time. It was felt, therefore, that model improvement should be accompanied by close interaction between policy analysts, other model users and model developers.

Suggestions of the workshop have been addressed in several SEAS development activities since its conclusion. Accompanying the preparations for the most recent reference projection being developed for EPA and DOE is a specification of "sytem bounds". Exhibit 1 from that task provides an outline of the pollutants that are judged to be reliable and accurate and the levels of regional/industry detail that are recommended for analysis. Focusing on this restricted set should make optimal use of the model at the present time.

3.0 METHODOLOGICAL ISSUES

While there was less agreement in this area than the previous one, several specific suggestions were made. One of these dealt with the need for a review of SEAS by outside experts. Particular emphasis was placed on identifying those relationships that have a foundation in regional and urban economic theory as opposed to those parts that are essentially of a computational nature with little emphasis on behavior. This review should of course, build on and update the Science Advisory Board Panel Review performed several years ago.

Next, there is a need to review existing multiregional econometric models with the objective of assessing whether one or more of these ought to be incorporated in or connected in some way with SEAS. Several available models were discussed in the workshop. These included MULTIREGION developed by the Oak Ridge National Laboratory (a model with BEA regions as the core unit); the NRIES model developed by the Bureau of Economic Analysis, a bottom-up model with states as the regional units; the Chase Econometrics Regional System with both a state-level model as well as a related system focusing on the 100 largest SMSAs in the country; the Wharton system (which currently focuses on the Census regions); the Interregional Input-Output model developed by Karen Polenske; and Harris' Interindustry Regional model.

Several criteria for model review were mentioned at the workshop and in the accompanying papers.

1. Level of regional detail: While there was agreement that counties were not an appropriate level of detail for a regional model, there was no agreement on what the appropriate unit is. Views ranged from those who thought a Federal region model was adequate to others who

Exhibit 1 - Bounds for Pollutants for the SEAS Reference System as of May 1, 1980

Pollutant Category	Pollutant	Region	Source
Air Pollutants	Particulates, SO_x, NO_x	National, Federal Region	Individual major energy and industrial sectors (e.g. old coal-fired utilities, aluminum industry)
		State	Individual conventional energy industries (e.g. coal-fired utilities) and aggregate of non-energy sectors (e.g. organic chemicals, iron and steel)
		AQCR	Aggregate trends - energy and non-energy industries
	CO, HC	National, Federal Region	Individual major energy and non-energy industries
		State	Aggregate trends
Point Source Water Pollutants	BOD, TSS, TDS, Oils and Grease	National, Federal Region	Individual major energy and non-energy industries
Nonpoint Source Water Pollutants	BOD, TDS, TSS	Federal Region Only Urban Runoff	Various urban land uses
		Agricultural Runoff	Production activities with the following 8 crops: corn, cotton, soybeans, wheat, tobacco, potatoes, citrus fruit and apples.
Water Consumption	Net Water Consumption	National, Federal Region and State	Individual manufacturing and energy industries
		ASA	Aggregate manufacturing and energy industry trends
Solid Wastes from Pollution Control	Ash and Char (flyash only)	National, Federal Region	Individual energy and non-energy industries
		State	Aggregate industry trends
	Sludge from SO_2 Removal (dry weight)	National, Federal Region	Individual conventional energy industries and Aggregate of non-energy sectors
		AQCR	Aggregate industry trends
	Other Industrial Sludges (wastewater treatment only)	National, Federal Region	Individual energy and non-energy industries
		State	Aggregate industry trends

emphasized states or BEAS. Moreover, since the latter two are not ideal from an environmental perspective, there was a recognition of the need to develop 'sharing' procedures (often referred to as a 'bridge matrices' or 'shift/share approaches') to disaggregate to the county and reaggregate to AQCRs or ASAs. This is a difficult issue since there appear to be as many of these 'sharing' algorithms as there are analysts. As an alternative, some participants suggested that, beyond the Federal region, case studies focusing on siting issues and their environmental and socioeconomic impacts might be adequate.

2. Compatibility with INFORUM: This is clearly important since consistency between national and regional forecasts is needed. However, it should be recognized that, depending on the multiregional model chosen, compatibility needs to focus on different variables (e.g., employment, output, investment, etc.). On a related issue the use of a bottom-up model leads one to question what the role of the current national I-O model should be. In addition, there is the question of whether SEAS ought to be flexible enough to be linked to more than one macrodriver.

3. Industry Detail: It was considered unlikely that any regional model can reliably project economic activity at the level of process/product detail used in SEAS for environmental calculations. Most of the models that were discussed focus on a broad (e.g., 2-digit SIC) level of detail. Since environmental projections in SEAS are done in various units (BTUs, tons, bushels) the question of 'aggregation' and 'bridge matrices' is again important.

4. Transparent structure: This is essentially the simplicity characteristic raised earlier. The methods should avoid any black box characteristics.

5. Interregional factors: The model must be able to capture linkages among regions in population and economic activity.
6. Policy aspects: Adequate policy handles must be specified in the model, including regulatory conditions, prices, tax variables, energy policy, etc..
7. Projection time frame: This differs significantly from model to model. While SEAS focuses on longer term trend projections, most econometric models have structures that are more suitable for short to mid term analysis. In particular, confidence levels on baseline projections are more difficult to find as one moves out beyond the first few years.

Since the completion of the workshop, a model evaluation task has been initiated. David Vogt of Oak Ridge National Laboratory will be carrying out this evaluation and making recommendations to EPA over the next several months.

While most participants emphasized the need for continuing to use a modular structure in SEAS, there were several comments on the need to incorporate more behavioral relationships and treat more variables endogenously rather than exogenously as is presently being done. Accurate replication of behavior by consumers and producers at a regional and interregional level inevitably involves some degree of simultaneity and trades off against the modularity and simplicity constraint.

Finally, there was considerable emphasis on the need for special analyses of environmentally sensitive industries. A major weakness of the current model is that changes in policy variables that affect location factors, such as energy prices, wage rates, material input costs, and environmental control costs are not related in any clear way to changes in locational decisions. There was a widely held view that this type of analysis should be done outside the model for several key industries. These include smelters, steel, petroleum refining and others. Some argued that this type of analysis could be performed for 'groups' of industries that are related in a locational sense with one member of the group being a leader. It was recognized that if this makes sense for most of the important industries a very detailed formal regional model may not be so important. The question of how one achieves consistency in a regional accounting sense across these many different elements was not resolved however. In actual practice, the task is clearly not trivial. Good locational studies in the tradition of Weber, Isard, Hoover and other are rare. And few of them have incorporated energy or environmental policy variables in their analysis of locational decisions. The decision of whether to undertake in-depth location studies or rely on the behavioral equations of econometric models like NRIES or MULTIREGION is not an easy one. As a first task, a survey of the literature as well as the formation of a panel of regional economists to provide guidance of this issue might be appropriate.

A related issue was the appropriateness of a SEAS regional capability siting and impact analysis of energy facilities. It was argued that a regional model could to provide a baseline against which the policy analyst might evaluate questions regarding the demographic and environmental impact of siting various types of major facilities (i.e. synfuels plants). The results of this type of analysis, if done for enough sites could then be generalized to evaluate impacts in a broader national sense. By limiting the regional scope, however, the remaining resources could be devoted to assessing additional considerations such as health and safety impacts.

4.0 DATA BASE DEVELOPMENT, DOCUMENTATION AND VALIDATION

Several issues were raised regarding data base development. There was emphasis on the fact that much of the regional data in SEAS needs to be updated.

This is particularly true for the non-energy sectors, where some of the data base year data is from 1971, but is also true for energy sectors which use 1975 as the base. While data availability is one of the key constraints in regional model development, it was recognized that one of the strengths of the SEAS model is its data base. It is critical, however, to know the source, reliability and relevance of all this detailed information. Also, the important issue of storing reliable historical data on residuals in SEAS was also raised. Past trends in environmental and economic activity could then be evaluated. This could serve both as an environmental track record for states (or other regions) and as a means for checking on some of the reasonableness of some model projections. Another important related point which was raised is the usefulness of the SEAS data outside the operation of the SEAS model. It was suggested that the data base might be restructured to be directly assessable without neccessarily requiring operation of the SEAS model. It appears that many analysis needs might be met simple by accessing and doing simple calculations with the data rather than operating the model each time.

The question of documentation was not a primary focus of the conference. Nevertheless, several participants pointed to the need for more analyst-oriented documentation. While there are volumes of documentation on individual parts of the model, it was recognized that improvements are needed to convey to the reader why a particular analytical method was chosen, how it compares to other methods and what are its strengths and weaknesses are. Finally, on the question of validation, one of the conference papers suggested that the results of region-specific models (e.g., for TVA) may be useful in improving the accuracy of SEAS through an iterative process of comparison, checking, data and methodology development.

5.0 CONCLUDING REMARKS

Several benefits of the workshop can already be identified. First, SEAS users and analysts were able to share ideas with representatives of many of the major regional modelling groups (Bureau of Economic Analysis, Oak Ridge National Laboratory, Wharton, Chase), as well as representatives of the academic community. The result was an open and thoughtful discussion of many of the problems and issues facing each of these groups. Second, some of the tasks that were recommended in the papers and the workshop are already in progress. These include (a) attempts to reconcile inconsistent regional forecasts at the product/process level (b) data base reviews; (c) evaluation of currently available regional models; and (d) additional efforts to document various parts of the model. Other tasks have yet to be undertaken but are currently being considered by EPA and DOE as a result of the recommendations of the group. Regardless of whether the focus of the model is on broad regions or units such as states or BEAs, the role of regional forecasting methods and development of necessary data bases is likely to be a central focus of attention in the future analysis efforts of both EPA and DOE.

APPENDIX A

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Appendix A

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APPENDIX B

WORKSHOP AGENDA

REGIONAL ECONOMIC MODELING WORKSHOP

AGENDA

Monday, October 15, 1979

8:00 Welcome and Opening Remarks
Lowell Smith, Acting Director, Program Integration and Policy Staff, EPA

8:45 Overview of EPA/DOE needs and desired regional economic capability --
Paul Schwengels, Program Integration and Policy Staff, EPA

9:00 Brief Description of the Current SEAS Regionalization Methods and the Rationale of their Development --
Nazir Dossani, Consad Research Corp.

9:15 Question/Discussion Period

10:00 Some Suggested Approaches to Meeting EPA/DOE Needs for Improved Economic Regionalization

Paper 1 - Peter Hall and Kevin Hollenbeck
Urban Systems Research and Engineering, Inc.

Paper 2 - Robert Nakosteen
Project Manager, Regional Economics Project
Tennessee Valley Authority

Paper 3 - David Vogt
Energy Division, Oak Ridge National Laboratory

Paper 4 - T. R. Lakshmanan
Chairman, Department of Geography
Boston University

Paper 5 - Barry Sedlick
Teknekron Research, Inc.

11:15 Respondents - Richard Ball
Chief, Methods and Data Evaluation Branch, DOE

Walter Page
Department of Economics
West Virginia University

11:35 Question/Discussion Period

12:15 Lunch

AGENDA (Concluded)

11:35	Explanation of Working Groups -- Paul Schwengels
1:30	Break up into small Working Groups
5:00	End of First small group period
5:00	No Host Cocktail hour

Tuesday, October 16, 1979

8:30	Convene Full Group for Discussion of Progress and Additional Clarification
9:00	Break up into small groups
12:00	Lunch
1:00	Convene Full Group (Each small group chairperson will present results with a period for discussion after each presentation.)
3:15	Break
3:30	Summary of Results and Expectations -- Haven Whiteside Strategic Analysis Group, EPA
3:45	Reactions to Workshop Issues and Conclusions -- Hugh Pitcher Economic Analysis Division, EPA

APPENDIX C

SMALL GROUP COMPOSITION

AND

DISCUSSION GUIDE

APPENDIX C

SMALL GROUP COMPOSITION

Group 1

Peter Hall
Frank Giarratani
Terry Morlan
Donna Upshaw
Paul Schwengels
Robert Honea
John Reuss

Group 2

Nazir Dossani
Bradley Perry
Arthur Katz
Kevin Hollenbeck
David Bennett
Richard Meyer
T.R. Lakshmanan

Group 3

Carol Metzger
Walter Page
Haven Whiteside
Richard Ball
Juan Gonzalez
Hugh Pitcher
Barry Sedlik

Group 4

Edward Preston
David Vogt
Robert Nakosteen
Kenneth Ballard
Merrilee Bonney

APPENDIX C

DISCUSSION GUIDE FOR SMALL GROUPS

This workshop is being conducted to provide information to EPA and DOE to be used in improving the regional economic projection capability within SEAS. The task for the small group discussions is to provide recommendations as to how this improvement should be carried out. A number of issues have been raised and suggestions made in the papers presented in the morning session. These will, hopefully, provide a starting point for discussion. In addition, the following list identifies some specific aspects of the question which should be considered in making recommendations.

1. Is the county the appropriate basic regional unit of analysis, or should another unit (e.g., BEA area) be selected?

2. A working assumption for this workshop has been that some relatively small-scale, incremental approach could be found to improve the economic regionalization associated with SEAS. Do you agree with this assumption or is a major alteration to SEAS structure required?

3. SEAS currently regionalizes economic activity in a core regionalization module and also for specific sectors (e.g. electric utilities, coal mining) within specialized modules.

a. Is this combination of regionalizing approaches appropriate?

b. How can consistency be maintained if both approaches are used?

4. Recommendations for improving the current regional economic modeling capability should include, to the extent possible, a discussion of the data requirements of recommended approaches and sources of data to meet these requirements.

5. What evaluation criteria should be used in validating an improved SEAS regionalization capability?

6. Should an improved regional economic capability attempt to incorporate more "behavioral" factors which explain shifts in economic activity between regional units? If so, what are the most important variables and how should they be incorporated?

7. Are there non-modeling approaches to industrial location, (e.g. expert opinion, case studies, etc.) which should be used? If so, how could they be used in conjunction with SEAS?

8. Should the economic regionalization capability be incorporated within SEAS or should it be a distinct but compatible model?

9. For some applications, it might be desirable for the user to supply economic regionalization exogenously to SEAS. How could the existing SEAS structure be modified to allow this option?

10. Resources for improving SEAS' regionalization are limited. How should the future regionalization development tasks be prioritized? What specific tasks should be undertaken in the short term (six months to one year)? What specific tasks should be undertaken in the longer run?

APPENDIX D

DESCRIPTION
OF THE
CEAI REGIONAL FORECASTING SERVICE

Appendix D

October 8, 1979

Mr. Paul Schwengels
Energy Processes Division
U.S. Environmental Protection Agency
Washington, D.C. 20460

Dear Paul:

I am writing to outline ways in which the CEAI Regional Service could be used to strengthen the regionalization of the Strategic Environmental Assessment System (SEAS). Attached is a summary description of the structure and methodology of the CEAI regional models.

As I understand SEAS, there are two major areas in which regionalization is carried out.

1. The core of SEAS uses the Interindustry Forecasting Model of the University of Maryland (INFORUM) to generate annual forecasts of industry activity at the national level. Following Cumberland's approach, effluent discharges, and the costs of reducing these discharges, are related to indutry output. Both industry output and discharges are regionalized using a share approach based on U.S. Commerce Department regional forecasts.

2. Energy is handled differently in that national totals are shared out by state and metropolitan area first, and then regional coefficients are used to develop discharges. These regional coefficients are based on surveys, state implementation plans, and the like.

My suggestion would be to follow the second approach, namely to develop regional activity by industry, first. The CEAI state models already do this at a 2-digit level of disaggregation. The SMSA models are more aggregated. Time-series data does not in general support greater than 2-digit industrial detail.

Two approaches can be taken to develop added detail. The first, and more expensive, is to develop stochastic equations for subsectors. There is not sufficient data to do this for most cases of interest.

The second, and more appropriate, is to use deterministic models based on the Census of Manufacturers, and other similar sources, to develop further detail.

All sectors can then be treated at the regional level. Regional effluent data on the chemical industry, for example, could be used to relate regional industry activity directly to effluents.

In summary, I would recommend that the CEAI regional models be used to provide the basic regional economic variables: output and employment by 2-digit SIC code, and personal income. The forecasts of these models are already consistent with the CEAI INFORUM model. CEAI has considerable experience relating these fundamental regional variables to such activities as coal mining and utility demand, on a regional level.

Thank you for inviting me to submit these suggestions.

Sincerely yours,

Bradley W. Perry
Director, Project Consulting
Regional & Energy Economics

THE CEAI REGIONAL FORECASTING SERVICE

DETAILED STATE AND METROPOLITAN (SMSA) FORECASTS

WHAT THE SERVICE PROVIDES

Data Bases

The CEAI Regional Data Bases contain over 35,000 time series. There are three databases, composed as follows:

1. The Regional Industry Data Base (10,200 series)
2. The State Data Base (9,996 series)
3. The SMSA Data Base (16,180 series)

These data bases include income, manufacturing, energy demand, housing, employment, consumption, price, labor force, cost, financial, and population variables. A detailed data base directory listing variable names, sources, frequency and starting dates is available upon request. All series are maintained in their original frequency (monthly, quarterly or annual) and are updated immediately upon release by the government, trade association or other source.

Forecast Variables

The variables forecast at the state level are given in Table 1. These variables are forecast for all 50 states and for the District of Columbia. All major categories of economic, demographic, cost and energy data are forecast, including industrial detail at the 2-digit SIC code level. The time horizon is ten years.

Table 1

LIST OF STATE VARIABLES

	Frequency
1. Personal Income	QTR
A. Wages in Manufacturing	QTR
B. Wages in Nonmanufacturing	QTR
C. Disposable Income	QTR
D. Other Labor Income	QTR
E. Proprietor's Income	QTR
F. Property Income	QTR
G. Transfer Payments	QTR
H. Personal Contributions to Social Insurance	QTR
2. Consumer Expenditures	
A. Retail Sales	QTR
B. New Passenger Car Registrations	QTR
3. Employment	
A. Manufacturing Employment	QTR
B. Nonmanufacturing Employment	QTR
1. Wholesale and Retail Trade	QTR
2. Services	QTR
3. Government	QTR
4. Other Nonmanufacturing	QTR
C. Total Nonagricultural Employment	QTR
D. Labor Force (Place of Residence)	QTR
E. Unemployment (Place of Residence)	QTR
F. Employment (Place of Residence)	QTR
G. Unemployment Rate	QTR
4. Population	ANN
A. Under 5 years old	ANN
B. 5 to 17 years old	ANN
C. 18 to 44 years old	ANN
D. 45 to 64 years old	ANN
E. 65 years and over	ANN
F. Net Migration	ANN

	Frequency
G. Net Migration rate per thousand	ANN
H. Total Quarterly (interpolated from annual data)	QTR
5. Residential Construction	
A. Housing Starts in Permit Issuing Areas (P)	QTR
B. Total Housing Starts (NP)	QTR
C. Single Family Housing Starts in Permit Issuing Areas (P)	QTR
D. Total Single Family Housing Start (NP)	QTR
E. Multiple Family Housing Starts in Permit Issuing Areas (P)	QTR
F. Total Multiple Family Housing Starts (NP)	QTR
6. Financial	
A. Demand Deposits	QTR
B. Time Deposits	QTR
C. Commercial Loans of Banks	QTR
D. Real Estate Loans of Banks	QTR
E. Loans to Individuals of Banks	QTR
7. Manufacturing Activity	
A. Shipments of Manufactured Goods	QTR
8. Manufacturing Activity by Industry	
A. Value Added (2-Digit SIC code)	ANN
B. Employment (2-Digit SIC code)	ANN
9. Relative Cost Data (ratio to the U.S. average)	
A. Industrial Electric Power	QTR
B. Industrial Natural Gas	QTR
C. State and local taxes	QTR
D. Manufacturing wages	QTR
10. Energy Demand	
A. Transportation	ANN
B. Residential/Commercial	ANN
C. Industrial	ANN
D. Utility Generation	ANN

The variables forecast at the SMSA level are given in Table 2. All of these variables are forecast for the 100 largest SMSAs (population 300,000 and above) while a smaller set is forecast for the remaining 150 SMSAs. Total personal income, employment and population are forecast for every SMSA where it is available.

As CEAI continues to expand and refine the system of state and SMSA models, the number of forecast variables will continue to expand. The system is not static but is constantly being modified to capture additional relationships among variables, to add detail, and to improve the efficacy of the system.

Quarterly Reports

The forecasts are produced four times yearly, and with each forecast an extensive set of analyses, graphs and tables are provided. The bulk of the report consists of the printed historical and forecast data tables with special emphasis on comparative performance. These are organized to facilitate state-to-state, state-to-region and state-to-national comparisons and are accompanied by written analysis of state and regional trends and events.

One entire volume is devoted to the overview and analysis of the forecast. Topics included in this volume are:

1. Summary of the U.S. macroeconomic assumptions
2. Regional overview and analysis
3. Special Reports
4. State Ranking and Summary Tables
5. SMSA Ranking and Summary Tables

Table 2

LIST OF SMSA VARIABLES

			Frequency
1.	Total Nonagricultural Employment		QTR
	A.	Manufacturing Employment	QTR
	B.	NonManufacturing Employment	QTR
2.	Personal Income		QTR
	A.	Wage Bill	QTR
	B.	Other Labor Income	QTR
	C.	Proprietor's Income	QTR
	D.	Property Income	QTR
	E.	Transfer Payments	QTR
	F.	Contributions to Social Insurance	QTR
3.	Department Store Sales		QTR
4.	Total Housing Starts		QTR
5.	Total Population		
	A.	Annual	ANN
	B.	Quarterly (Interpolated from annual data)	QTR
6.	Consumer Price Index		QTR

6. Census Division Reports
7. Consensus forecast

The Special Reports cover such regional issues as Three Mile Island, Tax reform (Proposition 13), Coal strikes, etc. The state and SMSA ranking tables rank order the regions in terms of key economic parameters such as personal disposable income per capita, employment growth and manufacturing activity. The entire state forecast is simulated using the "Consensus" as well as the CEAI "Standard" macroeconomic forecast.

Simulation Models

One state model, a group of state models or the entire 51 state network can be made available for client simulation on IDC's time-sharing system. These models allow the user to perform case studies using different macroeconomic scenarios, different state tax load or other relative cost assumptions, different migration estimates, etc. The user can also add detail in particular areas of interest or respecify equations.

The simulation capability is enhanced by a user-oriented simulation package which contains a simple report generator. An alternative U.S. macroeconomic scenario can be simulated, for example, with only five (5) instructions and at a cost of less than $50 per state.

(NOTE: The simulation models will not be available until December 1979).

MODEL STRUCTURE AND DESIGN

I. OVERVIEW

The models are econometric and have a quarterly period. The basic periodicity is given by the state income data, which is published quarterly. Because it runs quarterly, the model is able to capture the full business-cycle behavior of the economy, including the timing and amplitude of the turning points. An annual model is unable to do this.

Another general characteristic of the models is that they are policy sensitive: they respond to changes in tax rates, wage patterns, utility costs, etc. There are a number of reasons for this, and these will be highlighted as the description proceeds. A few of these reasons are the following:

1. Each state is modeled individually, with different structures according to the characteristics of the state.
2. National policy is explicitly captured.
3. The comparative advantage of one state over another is explicitly modeled using relative cost variables.
4. The use of the rational expectations approach captures the complicated interrelationships explicitly.

The rational expectations approach is one where only lagged independent variables are utilized. The permanent income hypothesis of Friedman is one example of this approach. It simply means that CEAI forecasts behavior as a function of the expected principle determinants of that behavior rather than as a function of past behavior. Adaptive expectations (using lagged dependent variables) is the name applied to the latter approach. Adaptive models are basically trend models. They do not behave well at turning points and constrain the long-run behavior of all variables to have the same relationship as that in the short-run, which is clearly not the case. Finally, because the lagged dependent variable captures many of the relationships between the dependent and the independent variables, elasticities change and fewer independent variables will enter the equation. Thus, we feel the use of a rational expectations model is more appropriate and will provide more powerful policy analysis.

II. THE TOP-DOWN-BOTTOM-UP APPROACH

The CEAI approach represents a complete departure from previous multiregional modeling and forecasting efforts in that the model has been built from the ground up. Most other regional models are constructed as proportions of the U.S. In CEAI, however, each region is modeled individually and then linked into a national system. Thus, the CEAI Regional models do not forecast regional growth as simple proportions of U.S. totals but focus on internal growth dynamics and differential business cycle response. This approach is referred to as "top-down-bottom-up." It contrasts sharply with share (top-down) models and models which are not linked to a national macroeconomic model (bottom-up).

The major components of the CEAI approach are listed in Table 3. In this table the model is divided into three parts.

1. The major linkages among the models occur in the economic base or export sectors. These we identify as primarily agriculture, mining, and manufacturing. In a few states, banking or insurance sectors also can be classified as export sectors. For the most part, these export sectors serve national rather than local markets. The income generated from these sectors provides one of the major stimuli to the local economy. And the local growth and decline of these sectors has a lot to do with the economic health of the region.

2. The local economy is composed of construction, transportation, utilities, finance, insurance, real estate, trade, services, and government. While the government's fiscal and monetary policy is important to this part of the economy, the major driving forces are local in nature. The money generated by the export sectors circulates and multiplies through the local economy and generates the greater part of regional employment. These interactions and simultaneities can only be captured in an independent model.

TABLE 3

CEAI APPROACH TO REGIONAL MODELING

THE EXPORT ECONOMY (Manufacturing/Mining/Agriculture)

- Business Cycle Response
  - Industrial Mix
  - Capacity Utilization
- Long-Term Growth
  - National Demand
  - Cost of Doing Business
- Local Activity

THE LOCAL ECONOMY (Other NonManufacturing)

- Activity in Export Economy
- Income/Employment Simultaneity
- National Conditions
  - Credit Availability
  - Government Spending
- Population by Age-Cohort

DEMOGRAPHICS

- Births
- Deaths
- Net-Migration as related to Economic Activity

3. In our demographic sector, both fertility and net migration are driven by economic conditions. The principal assumption here is that people follow jobs rather than vice-versa. This does not mean that there are no nonpecuniary determinants of migration. However, these are either fixed (climate and landscape) or vary only slowly (urbanization). The important thing is to provide the correct direction of causality. Demographic factors are most important on the consumption side of regional economy. They are a significant factor in housing, retail sales, autos, etc., and these relationships are captured in the models. But the major driving force of the regional economy is the economic base, not population.

Business Cycle Response

States respond differently to the business cycle. Every time the U.S. economy enters a recession, certain states are impacted far more than the nation as a whole while other states are impacted far less. This is particularly true of the industrial sector, but nonmanufacturing sectors are also affected differently. This stems from two factors. First, some segments of nonmanufacturing, such as utilities and transportation, depend heavily on industrial activity. Second, other segments, such as mining, have characteristics in common with the industrial sectors; that is, activity in different states is turned up or down at different rates as the nation progresses through a business cycle.

This differential response is a point we repeatedly emphasize. The CEAI Regional models, unlike "share" or "shift-share" models, are specifically designed to capture the response of individual states to fluctuations in the national economy. The nature of this response is discussed later in the text.

III. OUTLINE OF THE MODEL STRUCTURE

In the preceding sections we have been describing the general aspects of the model. Here we wish to outline the specific model structure. A schematic design of a typical state model is shown in Figure 1. For purposes of clarity, much of the detail is summarized. For example, personal income is treated as a single variable rather than in its nine components, and population is now shown.

The diagram clearly shows the top-down (related to the national economy) and bottom-up (intra-regional linkages, no sharing of national totals) nature of the model. The national and regional policy variables which are absent in share models are present in the CEAI model. The dynamic linkages and the quarterly period allow the model to capture the short-term behavior of the regional economy during upswings and downturns in the business cycle.

Finally, population, not shown in the diagram, is modeled as a function of and determinant of local economic performance. By forecasting the age detail of the state population, we are able to capture these long-term changes in consumer behavior which are related to the age structure.

These models capture each local area to the best of our ability. However, we recognize that there are improvements to be made and are continually expanding and refining the models. Very shortly we expect to add state energy demand. In the longer term we expect to add interregional commodity flows and to refine the financial sector.

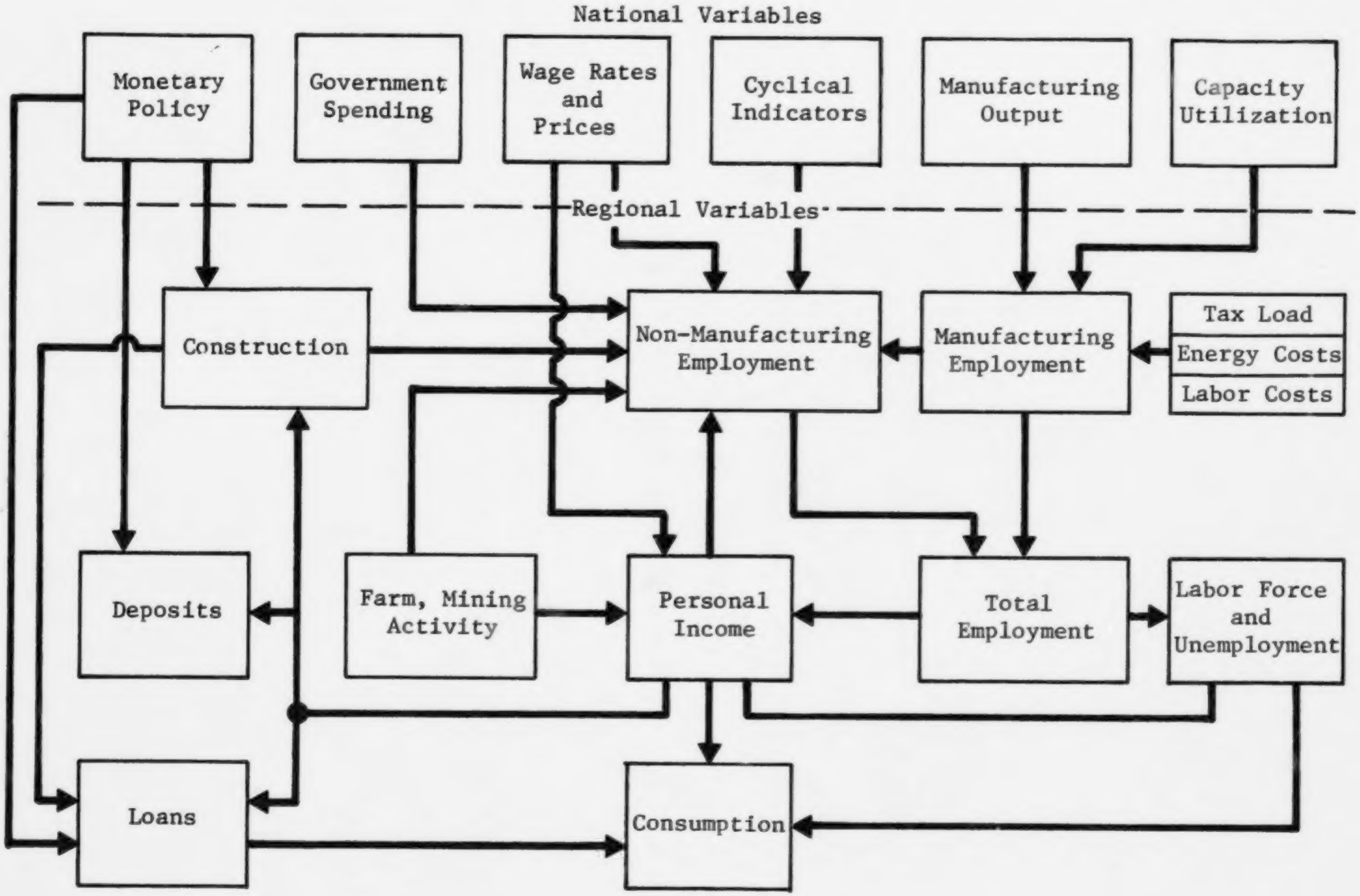
National Variables
Monetary Policy
Government Spending
Wage Rates and Prices
Cyclical Indicators
Manufacturing Output
Capacity Utilization
Regional Variables
Construction
Non-Manufacturing Employment
Manufacturing Employment
Tax Load
Energy Costs
Labor Costs
Deposits
Farm, Mining Activity
Personal Income
Total Employment
Labor Force and Unemployment
Loans
Consumption

FIGURE 1
CEAI REGIONAL ECONOMIC MODEL

APPENDIX E

WRITTEN RECOMMENDATIONS
RECEIVED AFTER THE WORKSHOP

College of Business and Economics
304 293-4092

Morgantown, West Virginia
26506

Bureau of Business Research

West Virginia
University

October 22, 1979

Mr. Paul Schwengels
1652 Irving Street, N.W.
Washington, D.C. 20010

Dear Paul:

Sorry I could not make it back for the second day. I simply was unable to complete the work in Morgantown.

Lowell asked that I send along any impressions, suggestions, etc. related to the workshop. I might mention the following points:

(1) Any short term efforts should, to the greatest extent possible, be consistent with a longer term strategy for improving the regionalization of SEAS. If, for instance, the long term strategy focuses on the BEA level, then the short term strategy, if possible, should also focus on the BEA level.

(2) I continue to believe that the BEA level, rather then the county, is the appropriate minimum spatial area for regionalizing economic activity. As noted during our small group session, the BEA area can also accomodate any larger region desired by appropriate aggregation.

(3) As the essential issue is the economic regionalization of SEAS, I would strongly recommend that DOE and EPA avoid farming out the work to noneconomists. It seems to me both agencies have had sufficient experience in this regard to make my suggestion rather obvious!

(4) The documentation and management issues continually dominated discussion during the workshop. I believe DOE and EPA should give serious thought to these matters and undertake appropriate actions to ameliorate the situation.

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(5) Procedures must be developed that permit interaction with the SEAS system by other modeling groups doing national or regional analysis for DOE and/or EPA. The current arrangements do not permit such interaction in an efficient (if at all!) manner.

Enjoyed the workshop. Good job! Say hello to all the many new friends I made during the workshop.

Sincerely,

Walter

Walter P. Page

/maa

cc: L. Smith

Chase Econometric Associates, Inc.

a Subsidiary of The Chase Manhattan Bank, N.A.
555 City Line Avenue, Bala Cynwyd, Pennsylvania 19004 (215) 667-6000 Telex: 831609

October 30, 1979

Dr. Lowell Smith, Acting Director
Program Integration and Policy Staff
U.S. Environmental Protection Agency
Washington, D.C. 20460

Dear Lowell:

I enjoyed the Regional Economic Modelling Workshop very much and appreciated the opportunity to participate. I am writing as you requested to provide you with my personal thoughts on SEAS and the direction it might take. These group as follows:

1. The strength of SEAS
2. Long-term development
3. Short-term development

The Strengths of SEAS

As I see it, SEAS has two strengths: INFORUM and RESGEN. INFORUM is still the best dynamic U.S. interindustry model and is specifically geared for the sorts of dynamic impact analysis in which EPA is interested. Interactive versions exist both at the University of Maryland and on the Interactive Data Corporation time-sharing system.

RESGEN is basically a databank on residuals generated per unit of some activity. To the extent that this databank is up-to-date, it is a very valuable tool. Certainly as much data as possible should be put into the databank, both regional and national averages.

The economic underpinnings of the other segments should be closely examined before any further work is done. For example, the "inside" equations for products and the logistics for processes appear to be based primarily on judgment.

Long-Term Development

A simple top-down-bottom-up model should be added to SEAS. At present, the data for a bottom-up model is just not there and consistency with INFORUM is desired in any case. The model should have the following characteristics:

1. It should include investment and capital stock because:
    a. The age of capital stock is important for both residuals generation and cost of abatement.
    b. INFORUM forecasts equipment investment at a 90-sector level using excellent behavioral equations.
    c. The growth and decline of regions depends, apart from special cases, such as agriculture and tourism, on investment.
2. It need not be designed at a single level. For example, consumption could be modeled at the Census Region level, investment and industry activity at the state level, and both of them could be shared down to sub-state economic areas.
3. Disaggregation and location of 2-digit sectors should be provided by a separate "unique locator" file. Examples are smelters, refineries, and power plants. The economics should determine when a new plant is needed, the locator file should determine where.

Short-Term Development

1. The clean-up activities suggested by our workshop group (2) should certainly be undertaken. There is no excuse for the complexity and long-turn around required by the present model.
2. RESGEN should be adapted so it can be driven by existing state models and/or forecasts. Many of the CEAI state models already can be simulated directly from time-sharing, and they also are driven partly by INFORUM. Such a combination would be satisfactory for much of the regional work described at the workshop.

I hope these comments are helpful to you in formulating plans for the future of SEAS. I would like to be kept informed of the future directions SEAS takes.

Thank you again for involving me in the workshop.

Sincerely yours,

Bradley W. Perry
Director, Project Consulting
Regional & Energy Economics

BWP:rea